MINING WORLD



Table No. 1

Projected Equipped Capacity for Copper Mines of the Free World in 1961 and 1965

Mine	Actual Output Largest Since 1955		Estimated Equipped Capacity	
	Tonnage	Year	End 1961	End 1965
UNITED STATES				
Utah	248,000	1956	236,000	236,000
Morenci	127,000	1956	140,000	140,000
Nevada Con.	47,000	1960	50,000	50,000
Ray	59,000	1960	72,000	72,000
Chino	70,000	1956	70,000	70,000
Inspiration	47,000	1959	47,000	47,000
New Cornelia	71,000	1959	72,000	72,000
Lavender Pit	40,000	1956	38,000	38,000
Yerington	43,000	1960	43,000	45,000
Miami, etc.	50,000	1956	35,000	35,000
Silver Bell	20,000	1956	20,000	20,000
Butte	96,000	1956	140,000	152,000
Magma	24,000	1956	24,000	24,000
White Pine	41,000	1958	60,000	100,000
San Manuel	82,000	1960	82,000	84,000
Pima	18,000	1958	18,000	24,000
Mission	—	—	45,000	50,000
C & Hecla	19,000	1956	19,000	18,000
Esperanza	25,000	1960	30,000	30,000
Bisbee (V.)	35,000	1957	35,000	35,000
Bagdad	12,000	1958	12,000	16,000
Banner	7,000	1956	7,000	7,000
Christmas	—	—	4,000	18,000
Others	47,000	1960	100,000	100,000
TOTAL			1,399,000	1,483,000
CANADA				
Int. Nickel	155,000	1960	175,000	187,000
Noranda	29,000	1958	30,000	30,000
Fa[illegible]ridge	[illegible]	19[illegible]	[illegible]	[illegible]
G[illegible]	[illegible]	19[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	19[illegible]	[illegible]	[illegible]
Campbell-Chib	[illegible]	1960	22,000	25,000
Geco	30,000	1958	30,000	30,000
Maritimes	13,000	1958	13,000	25,000
Normetal	12,000	1958	12,000	12,000
Opemiska	21,000	1960	21,000	21,000
Waite—Amt.	13,000	1960	13,000	13,000
Quemont	11,000	1957	11,000	12,000
Others	63,000	1960	74,000	75,000
TOTAL			[illegible]	[illegible]
SOUTH AMERICA				
El Salvador	87,000	1960	118,000	130,000
Chuquicamata	306,000	1959	306,000	310,000
Braden	192,000	1958	195,000	295,000
Cerro de P.	46,000	1957	45,000	45,000
Southern Peru	145,000	1960	150,000	150,000
Rio Blanco	—	—	60,000	60,000
Mantos Blancos	—	—	10,000	15,000
Others	82,000	1960	83,000	95,000
TOTAL			907,000	1,105,000

Mine	Actual Output Largest Since 1955		Estimated Equipped Capacity	
	Tonnage	Year	End 1961	End 1965
MEXICO—CUBA				
Cananea	32,000	1956	40,000	40,000
Others	50,000	1956	45,000	45,000
TOTAL			85,000	85,000
EUROPE				
Boldens	20,000	1958	20,000	20,000
Bor	39,000	1958	39,000	40,000
Majenpek	—	—	13,000	20,000
Outokumpu	33,000	1959	33,000	50,000
Rio Tinto	12,000	1959	12,000	12,000
Norway	16,000	1960	16,000	16,000
Ireland	—	—	—	10,000
Others	6,000	1959	6,000	10,000
TOTAL			139,000	178,000
AFRICA				
Mufulira	119,000	1960	126,000	180,000
N'changa	210,000	1960	210,000	225,000
O'Okeip	40,000	1960	40,000	40,000
Rhokana	122,000	1960	128,000	150,000
Roan Antelope	106,000	1959	106,000	125,000
Tsumeb	32,000	1958	32,000	32,000
Katanga	331,000	1960	340,000	435,000
Bancroft	61,000	1960	61,000	80,000
Chibuluma	24,000	1959	24,000	29,000
Chambesi	—	—	—	25,000
Baluba	[illegible]	[illegible]	[illegible]	[illegible]
Messina	17,000	1957	17,000	22,000
[illegible]	[illegible]	1960	18,000	18,000
Others	[illegible]	1960	19,000	20,000
TOTAL			1,121,000	1,381,000
AUSTRALIA—ASIA				
Japan	98,000	1960	98,000	100,000
Mt. Isa	79,000	1960	79,000	110,000
Mt. Lyell	12,000	1960	12,000	12,000
Atlas	21,000	1959	21,000	30,000
Lepanto	15,000	1960	15,000	15,000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Turkey	[illegible]	[illegible]	[illegible]	[illegible]
Others	52,000	1960	54,000	60,000
TOTAL			349,000	397,000
GRAND TOTAL			4,501,000	5,159,000

[illegible] Output from 1[illegible] to 1960 [illegible] America, Bureau of Mines Staff.

Note. Assuming a 1960 dollar and other economic conditions as existent in 1960, 90 percent of these totals could be produced at a cost range from 26 to 16 cents per pound. Only a small tonnage would cost more than 30 cents per pound.

A. B. PARSONS looks at copper mining in 1965 and previews industry in 2000 A.D. ▶24

How Humboldt Floats Michigan's specular hematite ore in expanded mill ▶30

Banner Mining completes new Palo Verde shaft in Arizona's Twin Buttes district ▶34

FIFTY CENTS **NOVEMBER 1961**



4½-yard P&H Electrics working at Craigmont Mines Limited's new mine near Merritt, B.C.

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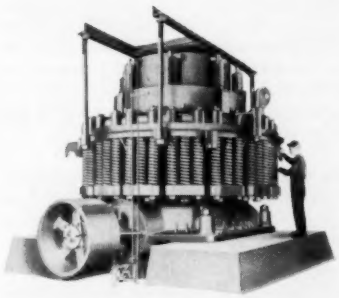
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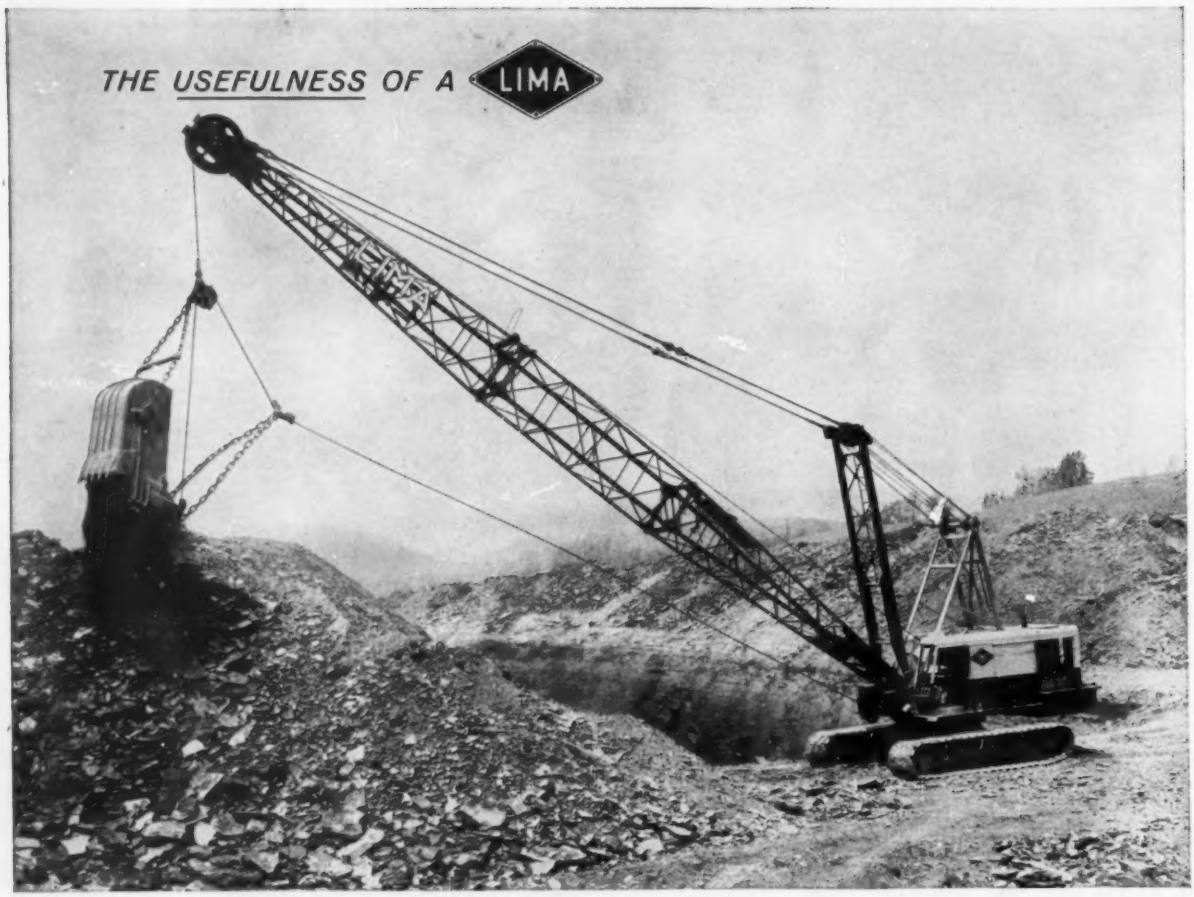
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MINING WORLD

VOL. 23, No. 12 November 1961

Copper mining as it will be 40 years from now is discussed by Arthur B. Parsons who sees a tremendous expansion of copper supply from low grade deposits, extensions of known ore bodies, and new discoveries 24

Humboldt Mining Company uses flotation to make a high grade specular hematite concentrate at its new mill in Michigan. This article is the second and concluding part of the story on this modern, integrated beneficiation plant, and describes the grinding and concentrating operations. 30

Banner Mining Company is pushing development of its Palo Verde mine near Tucson, Arizona, where it has some 60,000,000 tons of total copper ores available 34

Golden Jubilee celebration of froth flotation in the United States was recently held in Denver, Colorado, and 23 technical papers reviewed its importance to the metallurgical world . 36

Electrostatic precipitators treat kiln exhaust gas and recover an additional $125,000 worth of lithium aluminate for Foote Mineral Company 38

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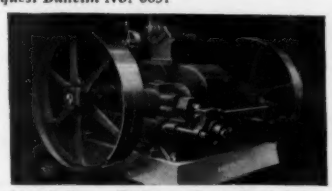
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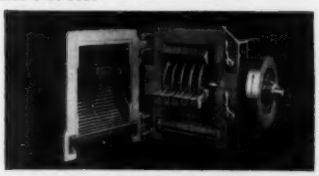
Jaw Crushers — Produce coarse (5 in. largest model) to fine (⅛ in. smallest model). Eight models range from 2 x 6 in. jaw opening (lab model) to 12 x 26 in. Capacities to 30 tph. All except two smallest sizes operate on double cam principle — crush double per energy unit. *Request Bulletin No. 062.*



Rotary Fine Crusher — Reduce soft to medium hard 3 to 8 in. material down to ¼ to 1¼ in. sizes. Capacities up to 30 tph. Smallest model has 6 x 18 in. hopper opening; largest, 10 x 30 in. Non-clogging operation. Single handwheel regulates size. *Request Bulletin No. 063.*



Crushing Rolls — Reduce soft to hard 2 in. and smaller materials to from 12 to 20 mesh with minimum fines. Eight sizes, with rolls from 8 x 5 in. to 38 x 20 in.; rates to 87 tph. Three types — Balanced Rolls; Plain Balanced Rolls; Laboratory Rolls — all may be adjusted in operation. *Request Bulletin No. 065.*



Hammer Mills — Reduce to 20 mesh. Swing-Sledge Mills crush or shred medium hard material up to 70 tph. Hinged-Hammer Pulverizers crush or shred softer material at rates up to 30 tph. Four Swing-Sledge Mills with feed openings from 6 x 5 in. to 20 x 30½ in. Four Hinged-Hammer Pulverizers with feed openings from 12 x 12 in. to 12½ x 24 in. *Request Bulletin No. 084.*

**Reports Manager W. Carleton Merrill concerning Sturtevant Swing-Sledge Mill at James F. Morse Co., Boston.*

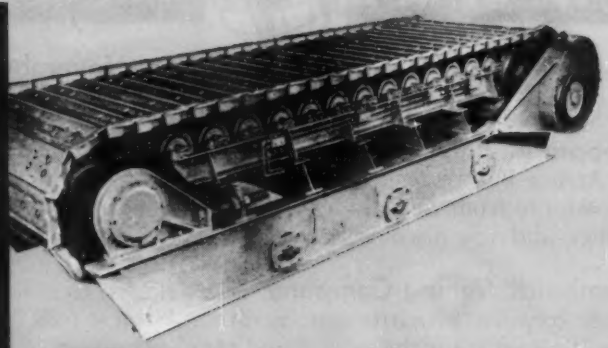
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GOVERNMENT ACTION AND REACTION AFFECTING MINING



Senate Passes Lead-Zinc Authorization Bill, But No Funds Available . . .

It is a considerable victory for the domestic small mine producers of lead and zinc that the President signed H. R. 84, the small mine lead-zinc subsidy phase-out bill.

Subsidy payments may be made on 1,500 tons of each metal to mines which have not sold more than 3,000 tons of combined lead and zinc during any period since January 1, 1956, to August 1, 1961, but which had some production during that period. It is estimated that the cost will be $4,500,000 the first year and will scale down to $3,500,000 the fourth year, or at a total cost for the four years of $16,500,000. The Interior Department proposes a much more modest bill and, as finally passed, H. R. 84 is a compromise between the original Edmondson bill and the Interior Department's proposal.

However, the now famous "phase-out" suggestion of the Interior Department was retained. This provision specifies that subsidies are to be paid on a gradually decreasing tonnage, obviously with the hope that the mines which can benefit eventually will come to the shut-down point again.

Since the bill only carries an authorization to appropriate, the House Appropriations Committee will have to be dealt with and money appropriated before the subsidy plan can be put into operation. There also is the hazard that money may not be appropriated for the succeeding years, a serious one for any company which has to invest capital in order to take full advantage of the subsidy.

The bill also contains a limitation on the amount of money which may be spent in each of the four years. This restriction could create a serious administrative problem in deciding how to divide the funds should production exceed the estimated amounts upon which the cost limitations are based.

The actual effect in increasing domestic production from these small mines cannot be known for a number of reasons until the subsidy program has been in effect for at least the first year.

Strict Prohibitions Are Written Into Wilderness Bill . . .

In reading S. 174, the Wilderness bill as passed by the Senate, one is struck by the explicit list of prohibition of uses of the Wilderness areas. It states that, "Except as specifically provided for in this Act and subject to any existing private rights, there shall be no commercial enterprise within the wilderness system, no permanent road, nor shall there be any use of motor vehicles, motorized equipment, or motor boats, or landing of aircraft nor any other mechanical transport or delivery of persons or supplies, nor any temporary road, nor any structure or installation, in excess of the minimum required for the administration of the area for the purposes of this Act, including such measures as may be required in emergencies involving the health and safety of persons within such areas."

Senator Allott remarked about this section of the bill, "I do not know what the latter portion means. I presume it means the Secretary, in case a person were dying in the middle of the wilderness, could authorize a helicopter to go into the area and pick the person up. Certainly a jeep, truck or car could not get into these areas without roads."

It looks as though the days of the horse are coming back!

Stockpile Disposals In The Wind—Now It's Molybdenum . . .

Little by little the government is getting authorization to dispose of "surplus" stockpile materials. The latest talk concerns the possible sale of molybdenum. The proposed release of large quantities of tin has disturbed world markets.

A long time ago Mining World warned that the Congress might get so in the habit of approving sales of stockpile materials that it would do so without adequate investigation.

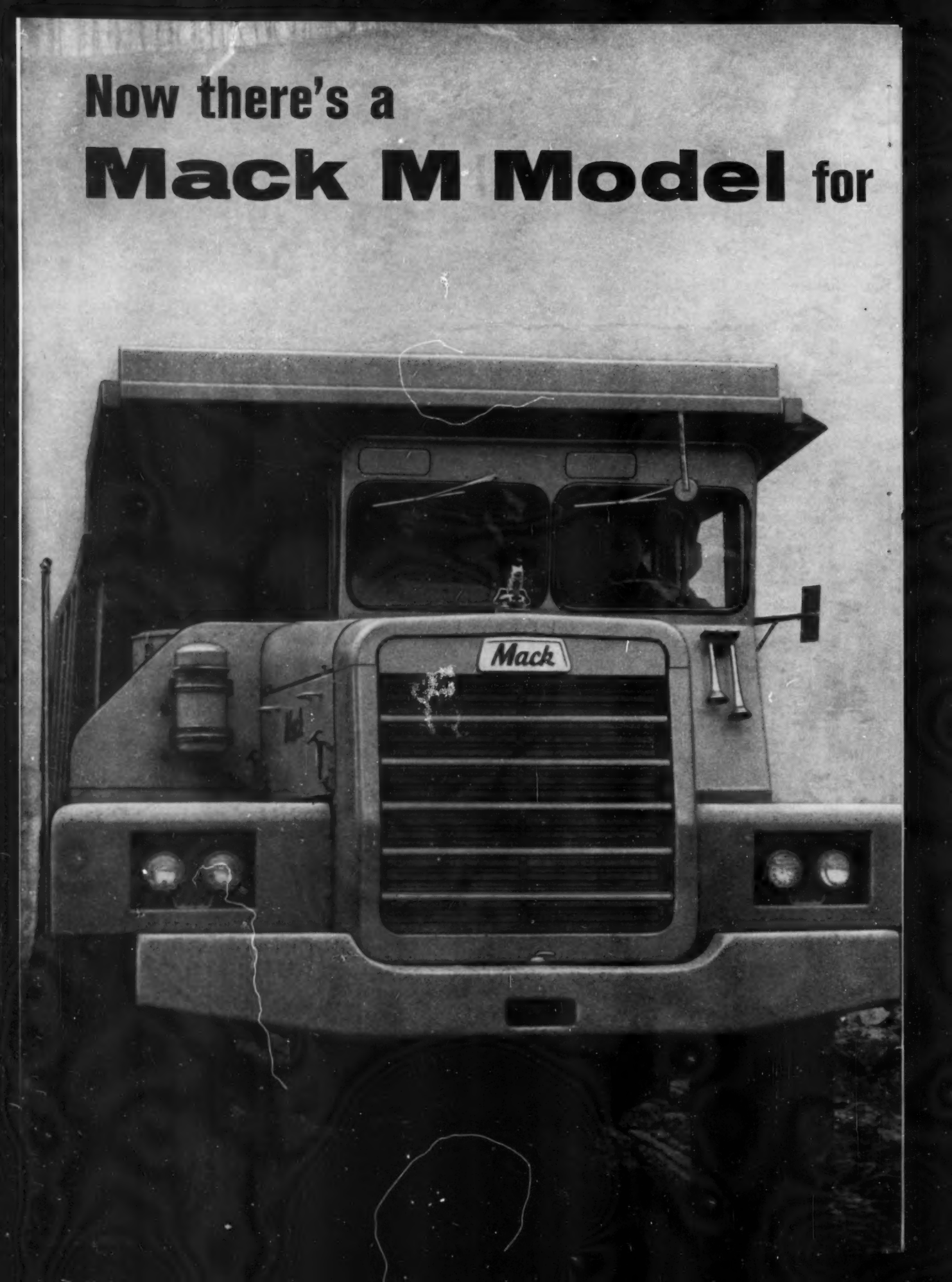
Metal Mine Safety Study Authorized For Two Year Period . . .

On September 26 President Kennedy signed into law the measure which directs the Secretary of the Interior to conduct a two-year study of safety and health conditions in metal and nonmetallic mines. His findings are to be reported to Congress together with recommendations "for an effective safety program."

The study authorized by the measure (H. R. 8341—Public Law 87-300) would cover 1. the causes of injuries and health hazards in metal and nonmetallic mines; 2. the relative effectiveness of voluntary versus mandatory reporting of accident statistics; 3. the relative contribution to safety of inspection programs embodying right-of-entry only or right-of-entry plus enforcement authority; 4. the effectiveness of health and safety education and training; 5. the magnitude of effort and costs of each possible phase of an effective safety program; and 6. the scope and adequacy of state safety and health laws relating to mines.

The measure further provides that the Secretary or his representative shall be entitled to admission to any mine or quarry for the purpose of gathering data and to require any reports from operators of such mines.

Now there's a
Mack M Model for



every practical off-highway job...

A year ago two new Mack M Models—a 45-ton six wheeler and 30-ton four wheeler—made their debut to receive an immediate acceptance unprecedented in off-highway operations. Now four additional M's are ready to take their place alongside the trailblazing two—a 15, 18, and 25-ton four wheeler and a 30-ton six wheeler. This pacesetting line of heavy-duty rear dumpers and tractors introduces a new dimension in profitable and practical off-highway hauling.

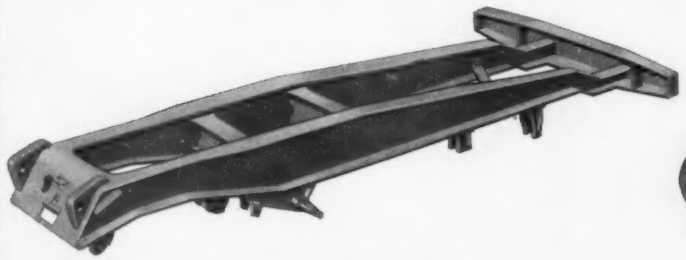
What's so special about the Mack M Models? To mention but a few features, there's a completely new cab design . . . there are improved new high strength, light-weight, longer-lasting single floor bodies—with or without heated floors . . . there are new Mack axles and bogies . . . there are newly engineered, extra sturdy frames . . . there are power options up to 525 hp to provide the getup and go that meets any challenge.

Most special of all, they're Macks . . . finest products of a line that has worked its way to the front in heavy-duty off-highway service. Add the extra features of the new M Models to Mack's already firmly established reputation for getting the job done at lower operating cost and with minimum downtime, and you come up with the answer to true off-highway efficiency.

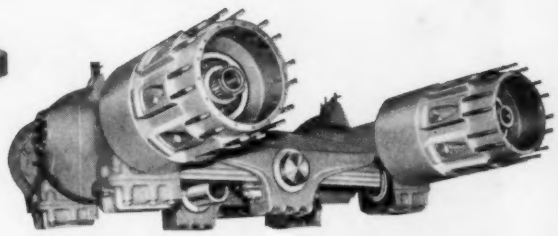
To select the right Mack for your own operations, contact your nearest branch or distributor. He's all set to show you what's so special about a Mack. Mack Trucks, Inc., Plainfield, New Jersey. Mack Trucks of Canada, Ltd., Toronto, Ontario.

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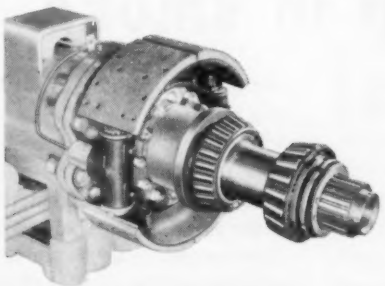
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TRUCKS



A NEW DIMENSION IN FRAME STRENGTH—Built to shrug off jarring shovel drops, the extra solid, extra strong five-crossmember frame of the M30X Mack is typical of the engineering advances in all M Models. Welded crossmembers, including integral front and rear bumpers, tie alloy steel fabricated I-beam main rails together.



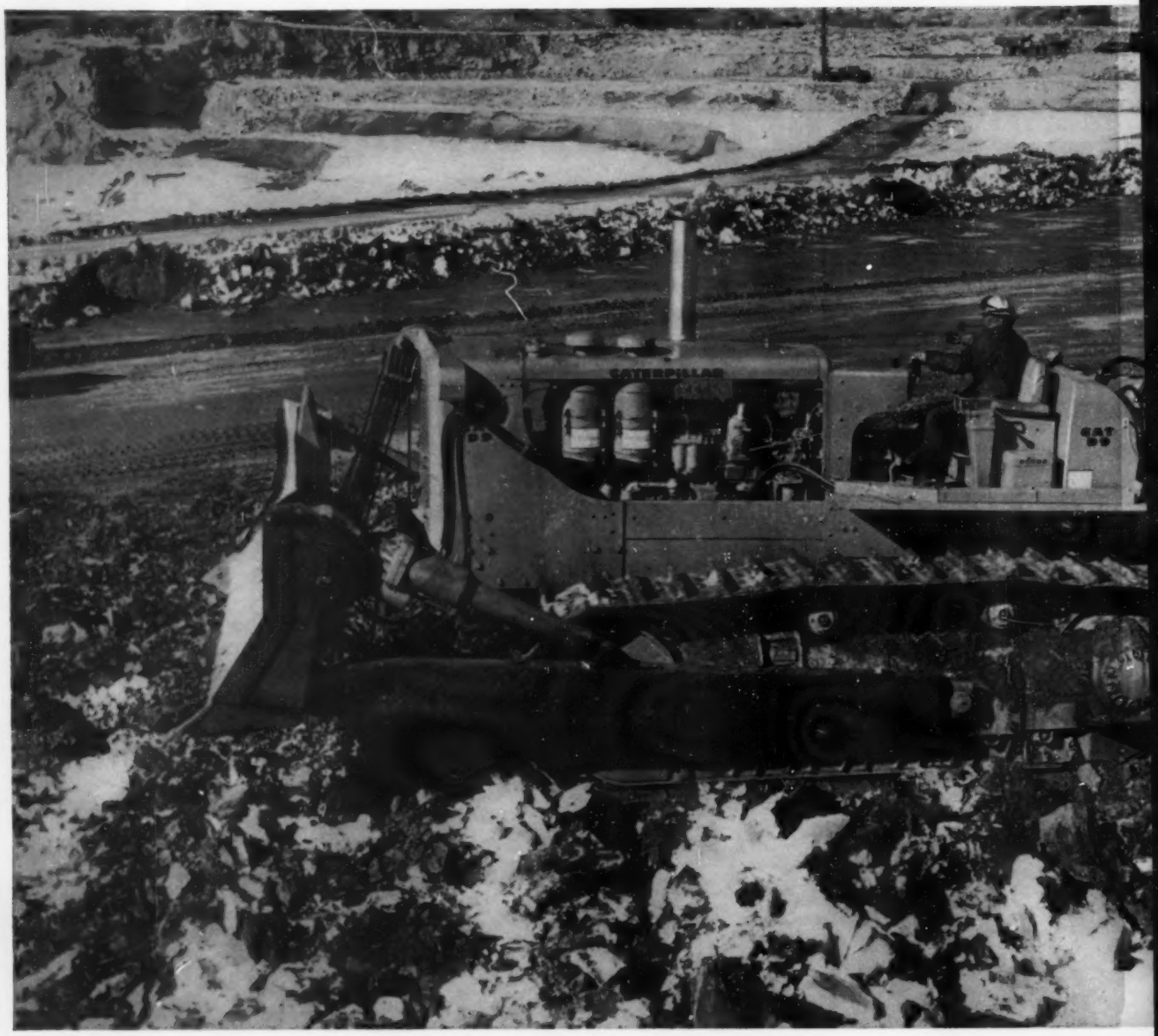
A NEW DIMENSION IN BOGIE PERFORMANCE—Indicative of advances in all Mack M Models, this newly designed heavy-duty twin-axle bogie on six-wheeler M45SX offers the strength and simplicity of straight-through drive and single-reduction carriers with Mack Planidrive reduction at the hubs. Unusual bogie flexibility results in exceptionally long tire life, reduces frame twist and wracking and keeps all wheels equally loaded. Suspension is through walking beam and flat leaf springs.



A NEW DIMENSION IN BRAKING SURENESS—Safe, sure braking power for maximum control at all times is another feature of all M Model Macks. Illustrated here is the air hydraulic rear braking assembly for the M30X and M45SX. Front brakes are air; rear are air hydraulic with separate master cylinders for extra safety factor.



A NEW DIMENSION IN FRONT AXLE LOADING—The new tubular front axle, featuring steel tubing seven inches in diameter with walls ¾" thick, provides a reversed-elliot front axle for the M45SX and M30X that easily withstands the additional loading made possible by Mack's new forward cab location.



If you're blasting rippable material, your money's going up in smoke

Mining operations are getting quieter. The reason is that more and more owners are replacing expensive blasting of ore and overburden with relatively inexpensive ripping.

The silence will never be complete, of course. Some material is simply not rippable, even with the brute strength of the big Caterpillar D9E Tractor.

But where material *is* rippable, it is considerably cheaper to rip than to drill and blast. Simple arithmetic supplies the most important reason. Add up these costs: power source, compressor, drills, drill bits, labor and supervision for drill and powder crews, dynamite truck, powder and primer, insurance, access roads and benching for drilling equipment.

Then compare the total with the owning and operating cost of a ripping tractor.

And there are other cost-saving advantages in ripping:

1. Ripped pieces of material tend to be smaller than blasted pieces, which means easier, faster handling and increased production. The spacing, depth and direction of ripping passes can be varied to obtain the desired size pieces, eliminating



HOW RIPPING WITH A D9E SOLVED A DIFFICULT AND UNUSUAL MINING PROBLEM

Mining of the main deposit had been completed at a uranium mine—but an excess of 50,000 tons of commercial grade ore still remained in scattered lenticular deposits around the bottom of the pit. They varied in depth from two to six feet, some occupying areas as great as 1000 square feet.

Problem: how to mine them economically.

Blasting would have been uneconomical since the commercial grade ore would have been diluted with surrounding low-grade ore and waste material. Shovel excavation without prior shattering would have been extremely slow, if possible at all.

Engineers suggested trying a tractor-mounted ripper. Tests indicated that this was the answer, and mine supervisors ordered a Caterpillar D9E Tractor with power shift transmission. Attachments included a No. 9 Ripper with two teeth and a No. 9S Bulldozer with tilt cylinder to give added prying action in digging out ore chunks in the more heavily consolidated portions of the formation.

The material is first ripped to a depth of 28 inches on 4-foot centers. Then it is cross-ripped (shown in photo at left) to break the heavily consolidated ore into easily handled pieces for shovel loading. The D9E bulldozes the pieces into a pile for loading into hauling units. Ripping and bulldozing production averages from 300 to 500 cu. yd. per hour. In addition the D9E handles road maintenance.

No other machine is as well suited to this kind of rugged mining work as the D9E. With 335 HP (flywheel) and a massive, long-lived undercarriage, it has the power and stamina to do the job. But, more important, it can do the job at *reasonable cost.* For the D9E's rugged construction and dependable Cat Engine mean that it stays on the job hour after hour, day after day, doing the work you bought it for.

Talk over your ore and overburden removal problems with your Caterpillar Dealer. If it is his best judgment that Cat-built equipment is the answer—he's ready to prove it to you with a demonstration.

Caterpillar Tractor Co., General Offices, Peoria, Illinois, U. S. A.

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expensive and time-consuming secondary blasting.

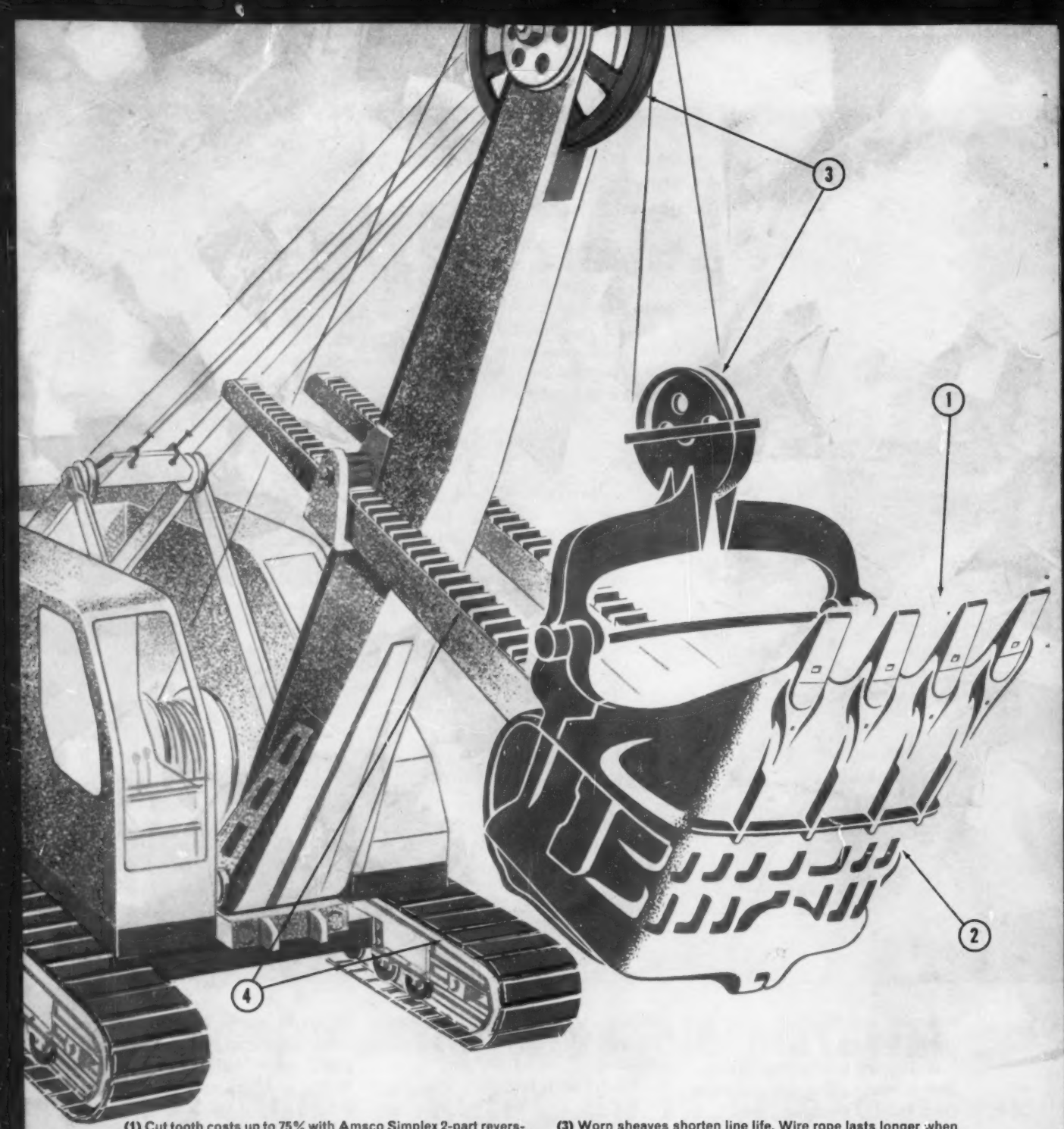
2. Ripping is safer than blasting. And in many cases this can mean lower liability insurance rates.

3. A ripping tractor offers the extra dividend of availability for various bulldozing jobs when it has completed its ripping assignments.

All told, the savings can be quite considerable. In fact, it is a rule of thumb that a ripping tractor used on a production basis can loosen ore and overburden for one-third to one-half the cost of drilling and blasting. In many cases, savings even top that. For example, on the Mesabi Range rock was ripped with D9s for *10% of the cost of drilling and blasting.*

The chart below gives some examples of typical savings. All are actual cases where Caterpillar track-type Tractors with rippers replaced drilling and blasting.

LOCATION	MATERIAL	Ripping Costs (Cents/Cu Yd.)	Drilling and Blasting Costs (Cents/Cu. Yd.)
Tulsa, Oklahoma	Limestone	7.3	17.3
Dallas, Texas	Limestone	5.2	15.1
San Francisco, Calif.	Sandstone	15.0	30.0
Merriam, Kansas	Sandstone	2.1	11.7
Nelsonville, Ohio	Sandstone	5.7	13.8
Philadelphia, Pa.	Limestone	11.5	19.3
Carbo, Virginia	Sandstone	8.6	15.7
Hibbing, Minn.	Frost	25.0	60.0
Hibbing, Minn.	Paint Rock	6.1	54.5



(1) Cut tooth costs up to 75% with Amsco Simplex 2-part reversible dipper teeth. Amsco Simplex teeth give you longer digging life while maintaining sharpness. Positive point-to-adapter pin locks stay tight under extreme conditions of impact, side blows, vibration or other shock. Simplex points stay on and are reversed in minutes per dipper. Replace present teeth with Simplex and measure the difference.

(2) Amsco dippers are made of manganese steel—"the toughest steel known"—containing 12-14% manganese. This tough steel provides as much as a 10 to 1 advantage over carbon steels under the abuse of impact and abrasion. Amsco manganese steel work hardens under impact, self-polishes under abrasion and is easy to weld when buildup or repair is needed. All types of dippers are made by Amsco—two-piece welded dippers, renewable-lip designs, Mesabi types, special dredge types and other styles to order.

(3) Worn sheaves shorten line life. Wire rope lasts longer when running in sheaves that stay smooth and even throughout their life. Ordinary flame-hardened steel or chilled cast iron sheaves score, wear and splinter. Splinters cut into wire rope. Amsco manganese steel sheaves work harden under repeated impact and acquire a polish that eliminates splinters. And when a high loading bangs the two sheaves together, Amsco sheaves take the beating without breaking.

(4) Tough, reliable Amsco crawler shoes give longer life for any shovel or backhoe. Amsco crawler shoes are available to fit every make of shovel or dragline and in special designs to order. Other Amsco shovel parts include racks, bevel gears, shipper shaft pinions, idlers, sprockets, dipper lips, fronts and doors. See your power shovel manufacturer for parts that give maximum service life and satisfaction.

TRUST THE COMPANY THAT BUILT YOUR SHOVEL

when ordering replacement parts

Manufacturers of power shovels and draglines can't take chances on inferior wear parts spoiling the good name of entire machines. That's why leading shovel manufacturers use dippers, teeth, crawler shoes, gears, racks and pinions, and sheaves made of Amsco Manganese and Alloy Steels.

They know, and so will you, that the same high quality found in original equipment castings is built into every Amsco replacement part offered. These parts will fit right and work right because they are designed to fit and be in balance on your equipment.

Your equipment manufacturer or his distributor is the best source of information on the *correct* parts to use—parts of genuine Amsco Alloy Steel.

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When you buy Timken® rock bits you are investing in a better value for today and in the future

Remember when you used to get 300 feet of hole from one rock bit in granite? It wasn't very long ago. Just about five years. Would you settle for the same footage today? Why should you? You can get 500 feet under identical conditions with a bit that costs less than your 300 footer.

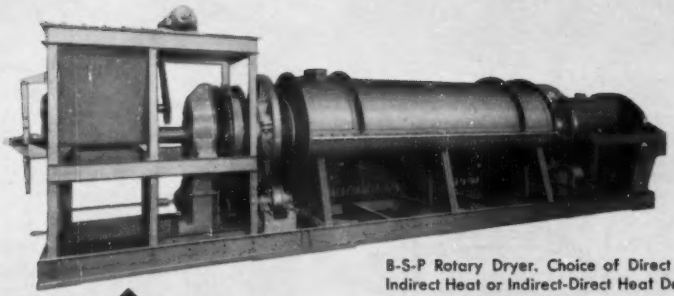
This extra footage, this reduction in cost per foot of hole, is the sum of many improvements in rock bit design, materials and manufacture—most of them pioneered by the Timken Company.

A large share of every Timken Company sales dollar is plowed back into research and development. For example, we lease a mine to conduct experiments that lead to better, more durable, more economical rock bits. Our Research Laboratory developed a new bonding process to hold carbides more securely to bit bodies. Our Rock Bit Engineering Department is constantly field testing new applications to overcome drilling problems. You see the results—and count the savings in dollars and cents—every time you drill a hole with Timken bits.

Underlying all these technological advancements is the philosophy of the Timken Company—Service to the customer. Our rock bit sales engineers are available for immediate service from branch offices and warehouses, located in principal cities throughout the country.

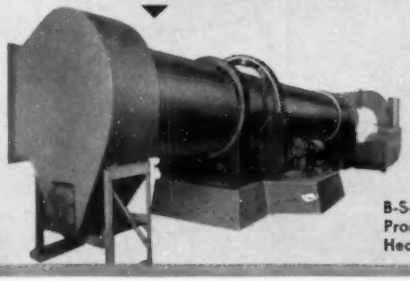
Customer service, product excellence and facilities to pioneer new developments have enabled the Timken Company to become one of the world's largest manufacturers of removable rock bits. It explains in part why Timken rock bits are preferred by so many drillers.

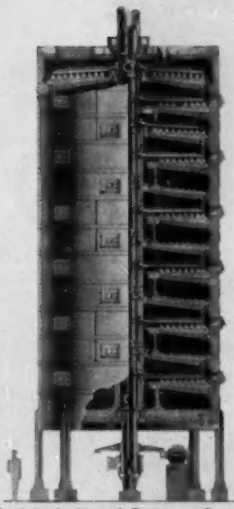
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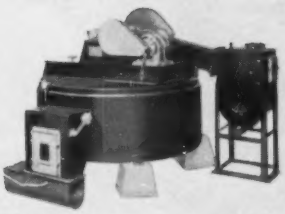
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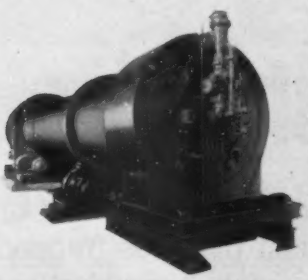
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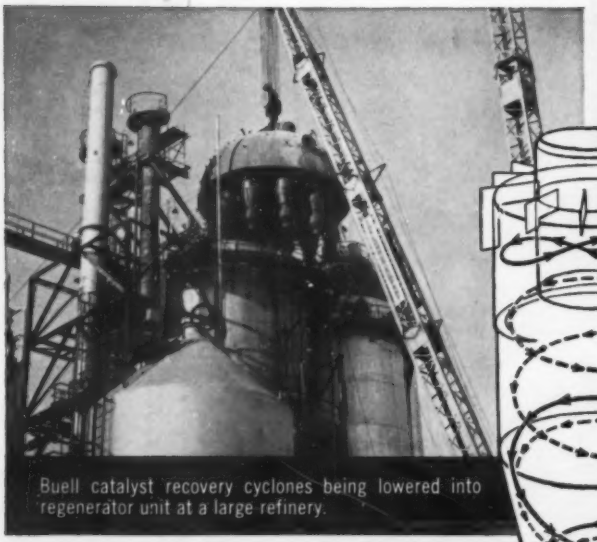
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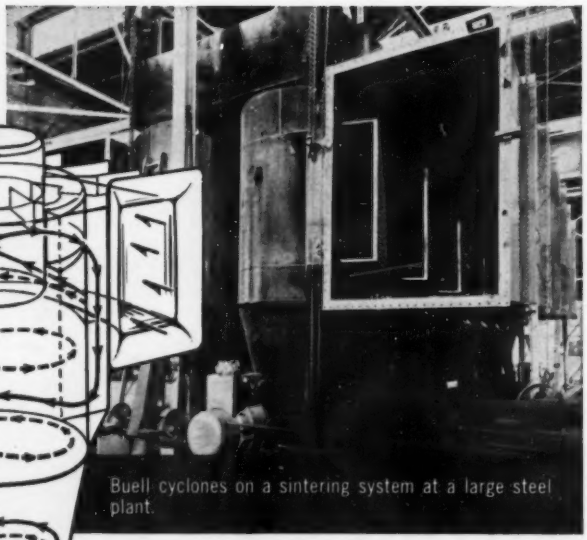
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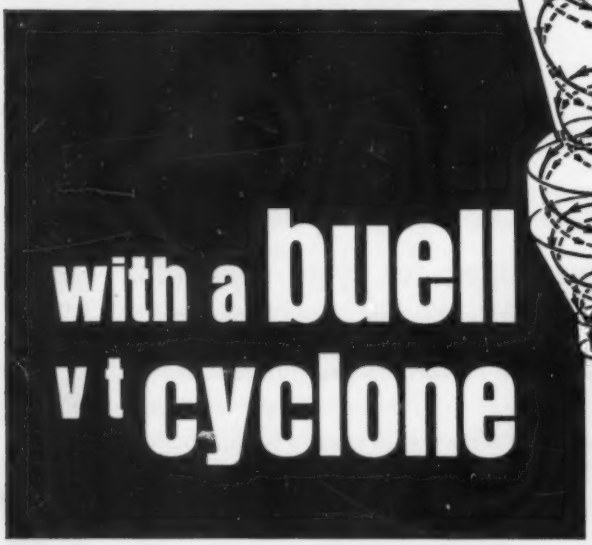
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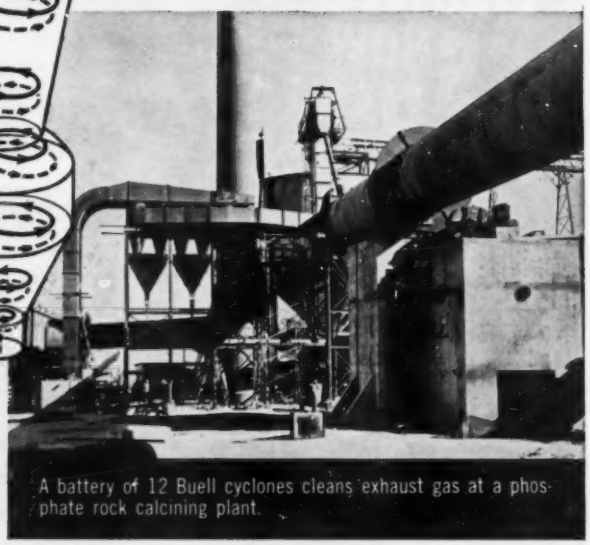
Buell catalyst recovery cyclones being lowered into regenerator unit at a large refinery.



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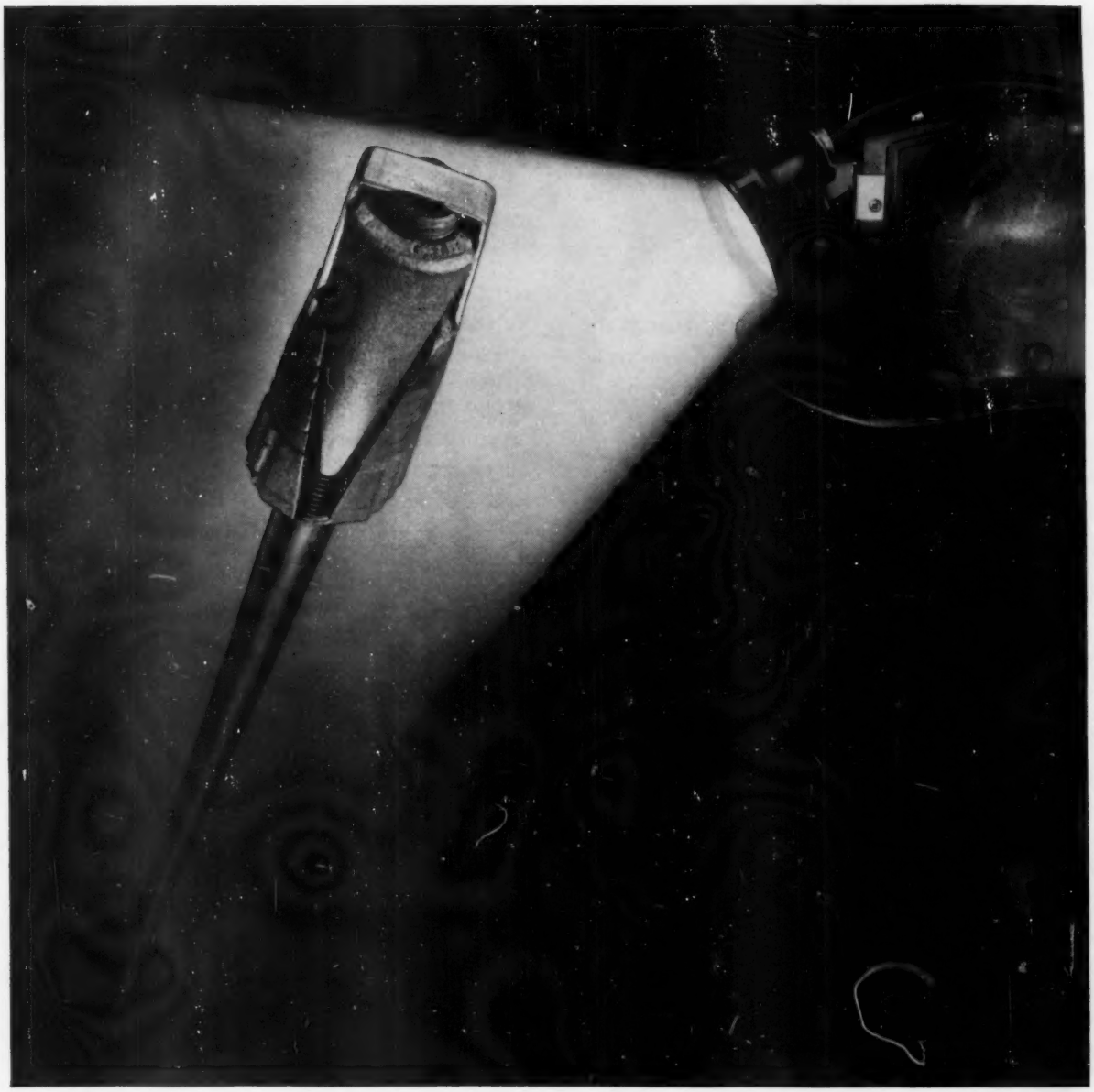


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"Our International TD-25 doubles load delivery of regular 'dozer blade . . . using V-type blade on spoil leveling," reports Partner Carl Sartori, Willowbrook Mining Co., Slippery Rock, Pa. On-course steering with this heavy offset load is achieved by upshifting speed of load-side track—to put extra power leverage where needed.

Pushes of over 600 feet pay off for Contractor C. R. Davis, Albuquerque, New Mexico—producing road gravel. Instant speed control of either or both tracks with the planetary transmission means positive load control—to heap the blade and "run" to the crusher. Then the "25's" high reverse of 7.5 mph means fast back-up for the next push. What would have been a costly two-tractor operation is efficiently done with one TD-25!

Doubling for dynamite—this TD-25 rips and breaks up a 30-inch vein of coal—to reduce cost of loading out with a 3-cu yd power shovel for Rice Brothers Coal Company, Phillipsburg, Pa. Power-on-both-tracks steering means "full speed ahead" with the ripper. The two TD-25's on this job team up with three draglines to move 25% of a 60-foot-deep overburden.

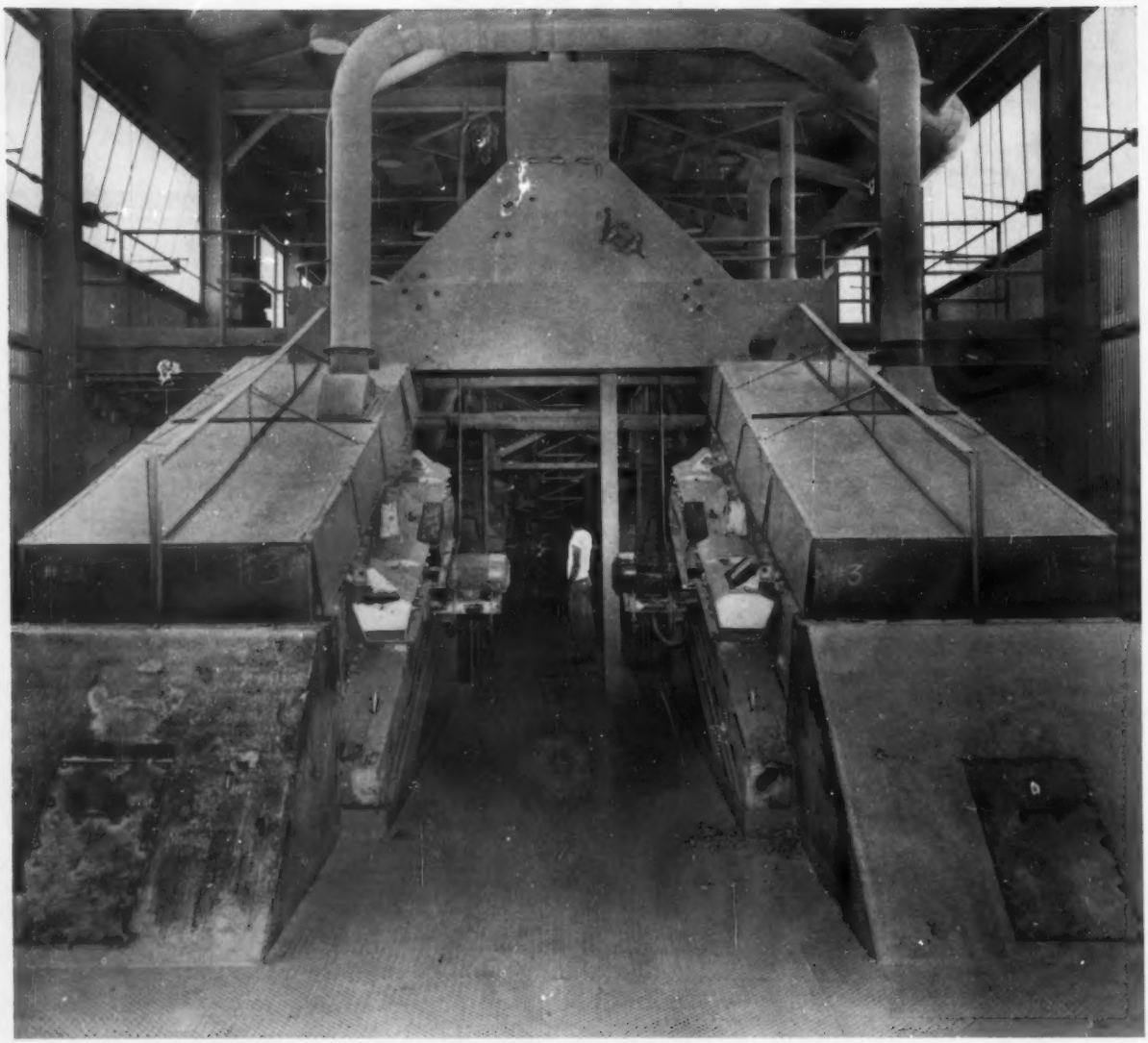




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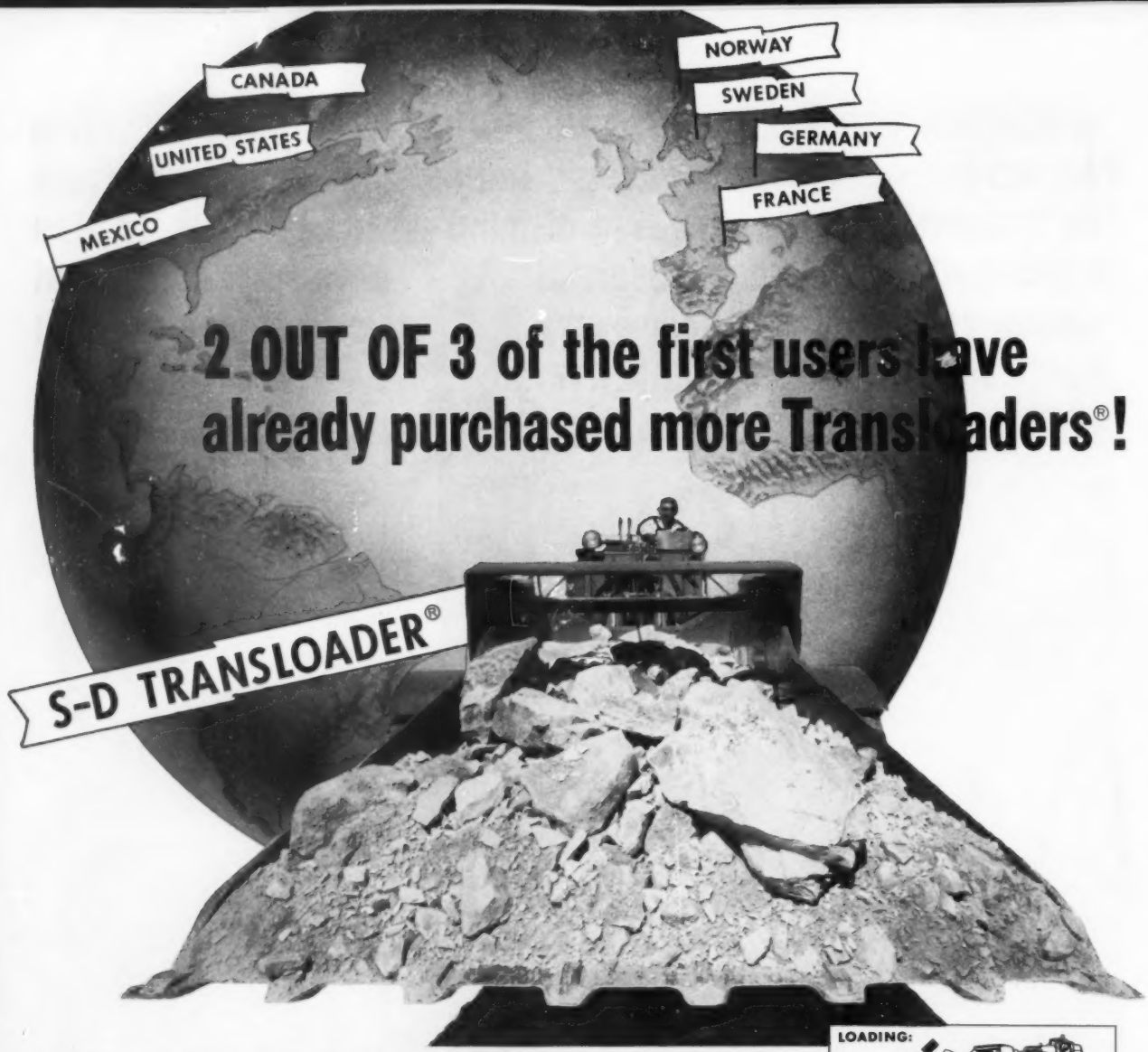
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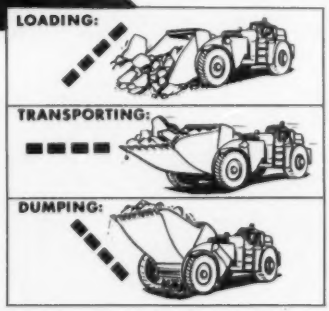
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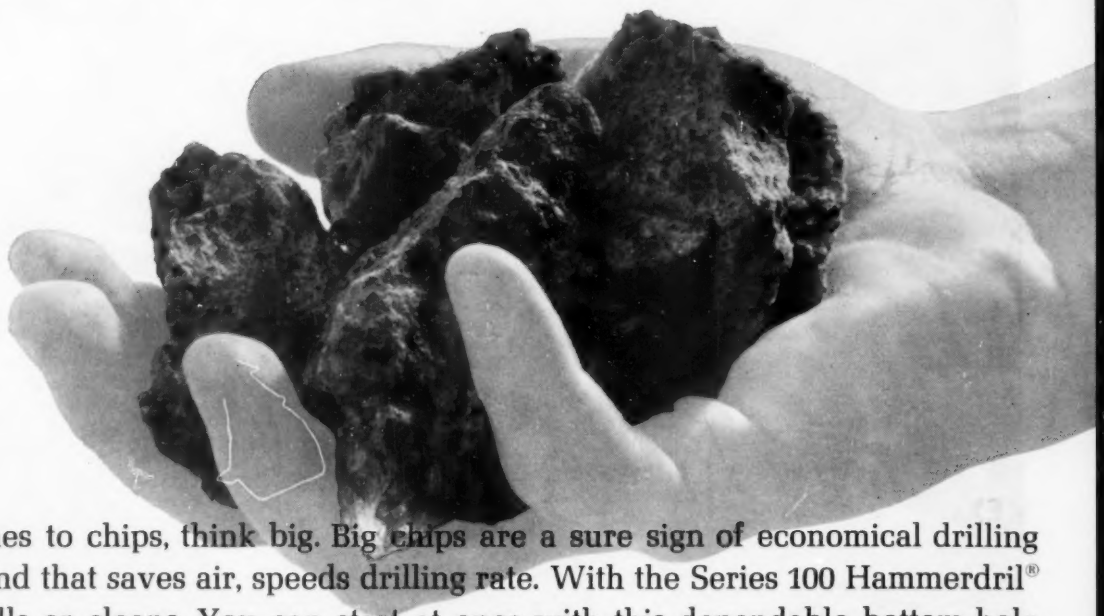
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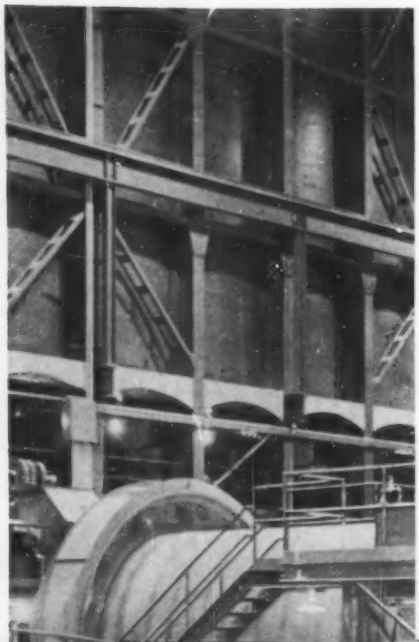
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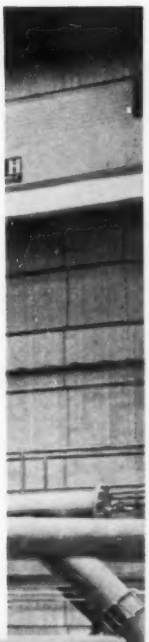
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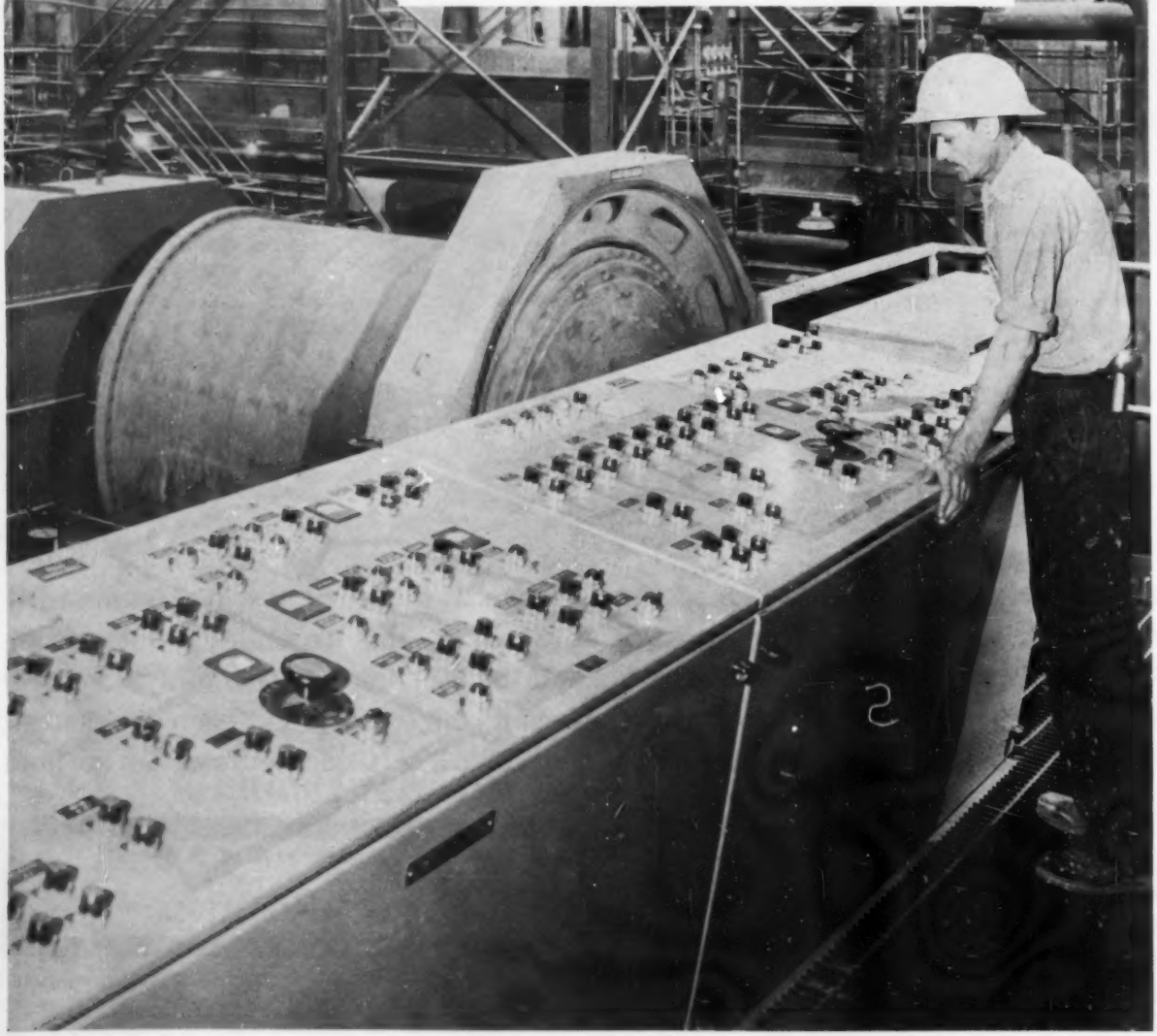
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Standard Metals Develops Sunnyside Veins.

The second phase of Standard Metals Corporation's long-range program to diversify from uranium into base metals is now underway at the American Tunnel in San Juan County, Colorado.

Today Standard's mine crews are working on "the development and preparation for mining" of the Washington and Belle Creole veins intersected at depth by the first phase of the program—the extension of the American Tunnel, and draining of old Sunnyside mine workings.

Development consists of drifting on the Washington Hanging and Foot Wall, and the Belle Creole veins on the American Tunnel level. Preparation for mining includes the just-completed installation of a new Ingersoll-Rand XLE compressor in an underground station at the end of the Tunnel. This machine, with a capacity of 2,300 cubic feet per minute, assures adequate air for development and mining. Its location close to the mining faces increases efficiency because there now is no pressure drop in the 10,305-foot line through the Tunnel from the portal compressors. In the tunnel 8,000 feet of track is being graded, ballasted, and relaid with 75-pound rail to speed ore haulage.

The raise from Tunnel level has been completed, 350 feet at 81° through to the "I" or lowest level in the old Sunnyside mine, reached through a long series of adits, drifts, and winzes. The shaft above I level is being retimbered to serve as the main service shaft between the Tunnel and upper workings. A hoist will be installed at the bottom. Shaft retimbering makes it possible to establish a large skip compartment through which today's large and high speed mining equipment can easily be transported between levels. The old cage and small compartments now make the original shaft useless. As timbering is completed to I level the new pilot raise will be slashed to full shaft size and retimbered.



STRONG WIDE VEINS are being developed by drifting on the American Tunnel level. Hanging wall is at right, but footwall is about six feet to the left out of the picture. Vein is predominantly rhodonite and quartz with sphalerite and galena.

With this work underway, manager Dave Hutchinson is planning to mine the large block of ore already developed in the Washington vein between F and I levels. His calculations show that sub-level stoping will be cheaper than shrinkage stoping in the wide veins. This method has the advantage, too, that larger equipment can be utilized for more hours of drilling time per man shift. With sub-levels 40 feet apart 1.3 tons of ore will be broken per foot of hole with 2.0 pounds of power.

Standard Metals continues to operate its Big Buck mine in San Juan County, Utah and ship low grade—0.20 to 0.26 percent U_3O_8 ore under favorable terms to Texas-Zinc Minerals Corporation.

Transarizona Resources To Triple Copper Output With Loan

Transarizona Resources, Inc. has negotiated a Small Business Administration loan with participating banks in the amount of $650,000. Funds will be spent to install two new furnaces and coolers at Lake Shore oxide copper mine south of Casa Grande, Arizona. This new equipment will bring the daily furnacing capacity to 750 tons which will lower cost per ton treated to the point where a profitable operation is envisaged. Transarizona has developed more than 2,000,000 tons of open pit copper assaying about 1.8 percent. Since this is oxide copper with too much lime for economical acid leaching, the firm has perfected the long known segregation process and successfully operated one furnace to treat 250 tons daily. This proved the feasability of the process in which ore, salt, and a solid carbon reducing agent are heated to about 750° C. Cuprous chlorides are formed which in turn are reduced to form metallic copper particles on the surface of the carbon. Calcine is then cooled, ground, and copper recovered by flotation. This is one of the first SBA loans granted to a mining company and the industry hopes that this will be a break through for further governmental loans to the mining industry. George A. Freeman of Casa Grande is general manager.

COPPER MINING — what to

By Arthur B. Parsons

Mr. Parsons is a consulting engineer with headquarters at 6091 Castle Drive, Oakland, California. He is the author of the two classic volumes on copper—"The Porphyry Coppers" published in 1933 covering the period from 1905 to 1931, and the "Porphyry Coppers in 1956" which covers the period from 1932 to 1955 and was published in 1957.

A fair question is: why, in a world so fraught with uncertainty—political, social, economic, and technologic—as ours of today: why speculate on something so far in the future. First—the uncertainties themselves give the problem a subtle fascination. Second—in examining the various possible courses of events pertinent points of near-term significance may develop; and forecasts of a qualitative—even if not quantitative—nature can be of interest. Third—as the late Louis S. Cates once remarked under similar circumstances" "'A.B.' one thing is certain—neither you nor I will be around to be embarrassed if the forecasts prove to be cock-eyed."

It may be pertinent to emphasize the fact that copper has a "world" market. Mines are found in every continent and in many countries, and, essentially, copper from any mine is as good as that from any other. It enjoys a per-pound price sufficiently high to warrant shipment anywhere it is needed. These facts tend to simplify a discussion of the outlook for the future.

As with any commodity in wide-spread use the problem has three elements:

1. **Demand—based on potential consumption.**
2. **Supply—having two factors:**
 (a) **Reserves of minable ore known to exist in the ground; and (b) capacity of plant erected and equipment installed to mine and process ore to produce marketable copper.**

Predictions are based on six important assumptions.

At the outset a few ground-rules can be setup that should tend to mitigate some of the uncertainty. These are:

1. It will be assumed that the human race is smart enough to avoid a holocaust that will reduce the population of the earth to 200,000,000 Chinese and some miscellaneous millions in Africa, South America, and other parts of Asia. Otherwise all bets are off and there will be no one to worry about copper mining in A.D. 2000.

2. Russia and its satellites will be excluded from the picture. This is unfortunate; but the fact remains that data regarding reserves, production, and consumption are too meager or too unreliable to warrant their use. There is evidence to suggest that the Soviet Bloc as now constituted will be obliged to draw substantially on Free World supplies to meet its needs, but in this article Russia et al are ignored.

3. The figures for past consumption and expectable demand used to prepare Chart No. 1 refer to newly-mined copper only. This is not to suggest that "secondary" copper is not an exceedingly important element. It is today; and it will become increasingly so. But its role is to supply an industrial alternate to newly mined copper and thereby to make the consumption of, and the demand for, new copper less than it otherwise would be.

4. All cost and price figures are stated in terms of 1960 dollars. To be consistent the prices used to plot Chart No. 2 back to 1913 have been translated to 1960 dollars by using the Wholesale Commodity Index of the U. S. Bureau of Labor Statistics.

5. A large proportion of the known and expected resources of copper are situated in "industrially backward" countries in which political upheaval is more than possible. However, it is reasonable to assume that political changes will not, more than temporarily, interfere seriously with the exploitation of these deposits. New governments or even old ones may exact a larger proportion of the realized profits by imposing duties, income or other taxes, or royalties. But these governments will not go far enough to stop or seriously curtail output—for long—simply because it will be to their interest to have exploitation procede efficiently, expeditiously and on a scale commensurate with the size of the deposits.

6. Estimates of production costs—past and future—include all direct and overhead expenses from initial exploration to the delivery of marketable metal; depreciation but not depletion; and ordinary taxes but not those based on income.

expect in the year 2000 A.D.

3. **Selling price—which in the long run must rule sufficiently in excess of the cost of production to provide a profit large enough to induce people who control capital to go into the copper mining business and stay in it.**

Demand and Consumption

Each of the foregoing elements is vitally dependent on the other two; but, to make a start, I will discuss Expectable Demand on the assumption that the supply, until A.D. 2000 at least, will be adequate at prices that will not exceed, and probably will range significantly below, double the average price for 1960. (32.053c at the refinery.)

The prima facie case for the foregoing assumption is this: experience has shown that in any region or area where huge tonnages of 1.0 percent ore have been found still greater tonnages of 0.5 percent "material" will exist. The per-pound-of-copper cost for mining and concentrating 0.5 percent might roughly be twice that of mining and concentrating 1.0 percent ore, but the corresponding cost for smelting, refining, and marketing should be substantially less than twice. Consequently, the postulation of adequate supply at a price well under 60c per pound is valid.

On Chart No. 1 have been plotted figures showing graphically the annual consumption of the Free World from 1910 to 1960, and two alternative extrapolations to represent the expected long-term trend until A.D. 2000. One leads to 6,200,000, the other to 7,000,000 tons. The vertical scale on the chart is arithmetic—that is to say a straight line, similar to the upper one, indicates a uniform increment each year—in this instance approximately 80,000 tons. If the same figures for consumption had been plotted on a chart having a logarithmic vertical scale a straight upwardly sloping extrapolation would have indicated a uniform annual *percentage* increment based on the preceding year. By this procedure a projected figure for A.D. 2000 could range from 8,000,000 to 10,000,000 tons depending on the judgment and predilections of the chartist. Some people might be inclined to regard my forecasts as being too low; and it must be admitted that they are necessarily conjectural—increasingly so, of course, for the period beyond, say, 1975. However, it is pertinent to set out some of the factors that have a bearing on the trend; and, as I have suggested, the comments will be more qualitative than quantitative.

Substitution—The thing that causes copper producers more apprehension than anything else is the use of substitute, or more properly, alternate materials. Aluminum for 20 years, or so, has displaced copper in high-tension long-distance transmission of electricity and is encroaching to some extent in other areas as a conductor of electricity. However, the greater threat is the use of alternates for purposes in which high electrical conductivity is not a factor. Brass and bronze, in which the copper content typically ranges from 65 to 90 percent, are of course

Table No. 1

Projected Equipped Capacity for Copper Mines of the Free World in 1961 and 1965

Mine	Actual Output Largest Since 1955		Estimated Equipped Capacity	
	Tonnage	Year	End 1961	End 1965
UNITED STATES				
Utah	248,000	1956	236,000	236,000
Morenci	127,000	1956	140,000	140,000
Nevada Con.	47,000	1960	50,000	50,000
Ray	59,000	1960	72,000	72,000
Chino	70,000	1956	70,000	70,000
Inspiration	47,000	1959	47,000	47,000
New Cornelia	71,000	1959	72,000	72,000
Lavender Pit	40,000	1956	38,000	38,000
Yerington	43,000	1960	43,000	45,000
Miami, etc.	50,000	1956	35,000	35,000
Silver Bell	20,000	1956	20,000	20,000
Butte	96,000	1956	140,000	152,000
Magma	24,000	1956	24,000	24,000
White Pine	41,000	1958	60,000	100,000
San Manuel	82,000	1960	82,000	84,000
Pima	18,000	1958	18,000	24,000
Mission	—	—	45,000	50,000
C & Hecla	19,000	1956	19,000	18,000
Esperanza	25,000	1960	30,000	30,000
Bisbee (V.)	35,000	1957	35,000	35,000
Bagdad	12,000	1958	12,000	16,000
Banner	7,000	1956	7,000	7,000
Christmas	—	—	4,000	18,000
Others	47,000	1960	100,000	100,000
TOTAL			1,399,000	1,483,000
CANADA				
Int. Nickel	155,000	1960	175,000	187,000
Noranda	29,000	1958	30,000	30,000
Falconbridge	18,000	1960	18,000	18,000
Gaspe	35,000	1960	35,000	35,000
Campbell—Chbgm	18,000	1960	22,000	25,000
Hudson Bay	45,000	1958	47,000	47,000
Geco	30,000	1958	30,000	30,000
Maritimes	13,000	1958	13,000	25,000
Normetal	12 000	1958	12,000	12,000
Opemiska	21,000	1960	21,000	21,000
Waite—Amt.	13,000	1960	13,000	13,000
Quemont	11,000	1957	11,000	12,000
Others	63,000	1960	74,000	75,000
TOTAL			501,000	530,000
SOUTH AMERICA				
El Salvador	87,000	1960	118,000	130,000
Chuquicamata	306,000	1959	306,000	310,000
Braden	192,000	1958	195,000	295,000
Cerro de P.	46,000	1957	45,000	45,000
Southern Peru	145,000	1960	150,000	150,000
Rio Blanco	—	—	—	65,000
Mantos Blancos	—	—	10,000	15,000
Others	82,000	1960	83,000	95,000
TOTAL			907,000	1,105,000
MEXICO—CUBA				
Cananea	32,000	1956	40,000	40,000
Others	50,000	1956	45,000	45,000
TOTAL			85,000	85,000
EUROPE				
Bolidens	20,000	1958	20,000	20,000
Bor	39,000	1958	39,000	40,000
Majenpek	—	—	13,000	20,000
Outokumpu	33,000	1959	33,000	50,000
Rio Tinto	12,000	1959	12,000	12,000
Norway	16,000	1960	16,000	16,000
Ireland	—	—	—	10,000
Others	6,000	1959	6,000	10,000
TOTAL			139,000	178,000
AFRICA				
Mufulira	119,000	1960	126,000	180,000
N'changa	210,000	1960	210,000	225,000
O'Okeip	40,000	1960	40,000	40,000
Rhokana	122,000	1960	128,000	150,000
Roan Antelope	106,000	1959	106,000	125,000
Tsumeb	32,000	1958	32,000	32,000
Katanga	331,000	1960	340,000	400,000
Bancroft	61,000	1960	61,000	80,000
Chibuluma	24,000	1959	24,000	29,000
Chambesi	—	—	—	25,000
Baluba	—	—	—	35,000
Messina	17,000	1957	17,000	22,000
Kilembe	16,000	1960	18,000	18,000
Others	6,000	1960	19,000	20,000
TOTAL			1,121,000	1,381,000
AUSTRALIA—ASIA				
Japan	98,000	1960	98,000	100,000
Mt. Isa	79,000	1960	79,000	110,000
Mt. Lyell	12,000	1960	12,000	12,000
Atlas	21,000	1959	21,000	30,000
Lepanto	15,000	1960	15,000	15,000
Cyprus	40,000	1959	40,000	40,000
Turkey	27,000	1960	30,000	30,000
Others	52,000	1960	54,000	60,000
TOTAL			349,000	397,000
GRAND TOTAL			4,501,000	5,159,000

Source of output from 1955 to 1960, American Bureau of Metal Statistics.
Note. Assuming a 1960 dollar and other economic conditions as existent in 1960, 90 percent of these totals could be produced at a cost range from 26 to 16 cents per pound. Only a small tonnage would cost more than 30 cents per pound.

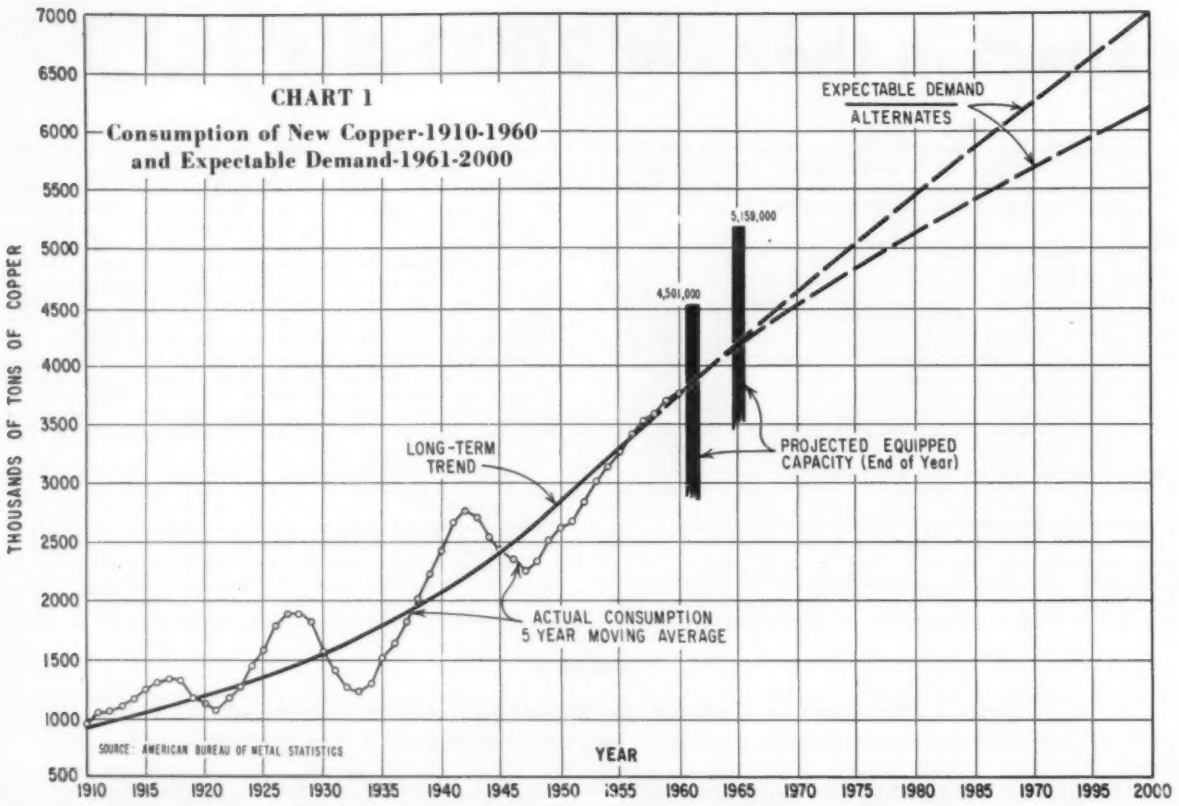


CHART 1. Consumption of "new" copper, 1910 to 1960 and expectable demand for 1961–2000 in the Free World.

vulnerable in this respect as well as copper itself. The list of alternative materials is long and is growing.

Thirty copper-producing companies a few years ago established a Copper Products Development Association to conduct technical research and in other ways to stimulate the use of copper and its alloys. The fact that this joint venture was launched suggests that the keenness of competition from many directions was felt by the producers. No doubt the C.P.D.A. will prove helpful; but in the long run it seems inevitable that copper and its alloys must take a back seat in favor of competitive materials for a wide range of uses for which electrical conductivity is not needed. Generally speaking the price will be a controlling factor. Soaring prices in 1955 and 1956 (ranging from 42 to 46 cents for 10 months) caused copper producers grave concern; and many of them concluded that a price above 32 cents for any sustained period would generate large-scale substitution especially in non-electrical uses. Such uses roughly account for one-third of the total consumption in the United States and presumably about the same proportion for the world at large. I predict that in 15 years, and perhaps sooner, copper will be priced-out of a large part of the non-electrical market. That is one of my main reasons for postulating on Chart No. 1 a less rapid growth in the rate of consumption than many people deem probable.

Electricity—On the other hand, even if a substantial share of the non-electrical consumption is written-off, I foresee steady expansion in consumption because of the sustained growth of the electrical industry in all its phases. Two assumptions are basic:

Assumption 1—Electricity will continue to be the chief medium by which energy will be packaged, transported, and utilized either as heat or as mechanical power. This will be true no matter whether the prime source of energy is falling water, or ocean tides; the combustion of coal, oil, or gas; thermonuclear phenomena; the concentration of the rays of the sun—or something else.

Assumption 2--Copper will continue to be an indispensable conducting metal with which to generate, and apply, and in lesser degree to distribute, electricity.

As to Assumption 1, the convenience, the efficiency, the flexibility of electricity are unrivaled. For example, a Diesel locomotive uses a petroleum product as the primary source of power; but it uses electric generators and electric motors to translate the energy to the wheels of the locomotive.

Technologic progress could in 40 years, or less, devise apparatus, equipment, and procedures that would vitiate Assumption 1; and my thesis, admittedly, is based on its essential validity. Some will quarrel with the word "indispensable" in Assumption 2. Going too far they contend: and perhaps it would be safer to say "the premier" conducting metal. Technologic development must be considered. Perhaps a practical way of wireless transmission of electric energy will be devised; but if the atmosphere were full of electricity it would be difficult to police hi-jackers! It is not impossible that some synthetic material or some alloy may be perfected as a satisfactory alternate to copper as a conductor of electricity; and, of course aluminum always will be a potential competitor. The relatively great bulk of an aluminum, as compared with a copper, wire required to conduct a given amount of electricity is its greatest handicap; but, as always, the price per-unit-of-capacity plays a critical role. Rightly or wrongly I have postulated that for most, but by no means all, areas of electrical use copper will retain the higher price-capacity-

A. B. Parsons sees tremendous expansion of copper supply

To begin with I will make the flat statement that the world will never "run-out" of copper. It is true that the supply of copper is not "inexhaustible" in the sense that this term can be applied to the supply of iron, aluminum, and magnesium. Of these there exist "unlimited" deposits that can be exploited at feasible cost by methods now known.

But as long as humans need it, copper will be obtainable. They may get it from the bottom of the ocean—they may even get it from the moon! The per-pound cost of production may be many times that prevailing today; and it may be reserved for uses for which it is uniquely suitable; but ore in the ground and facilities for mining it will be available.

The problem as it concerns A.D. 2000 is more simple. Table No. II is a geographical compilation of the estimated

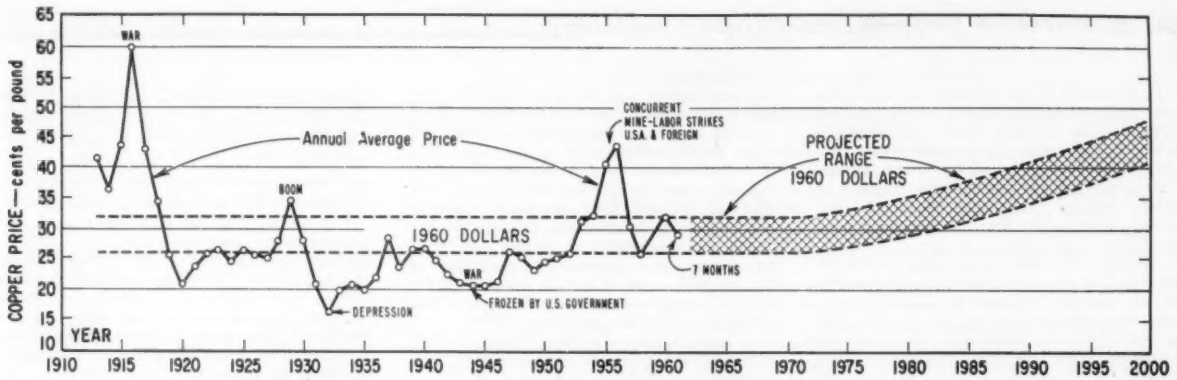


Chart 2: Domestic Price of Copper 1913–1961 and Projected Range 1962–2000 expressed in 1960 Dollars. **Source: Year Books of the American Bureau of Metal Statistics.**

efficiency coefficient of the two metals.

Next comes the question: How fast will the business of using and therefore producing electric energy expand in (a) the United States; (b) other industrialized countries, principally Canada, Australia, and most of Europe; and (c) the so-called "backward" countries. Crystal-ball forecasts of the Federal Power Commission are that the output of the United States in 1980 will be 2,084,000,000,000 kilowatt hours, compared to 760,000,000,000 in 1960—or an increase of 175 percent. This, by the way, is considerably lower than the forecast of the *Electrical World*. Relating these figures to estimated population (180,000,000 in 1960 and 255,000,000 in 1980) the per-capita increase is 95 percent. In other words, the per-capita consumption of electric energy is expected almost to double in the period 1960–1980.

Even if this forecast should prove to be accurate it does not by any means follow that the demand for copper for electrical purposes will double in the same period. For one thing technologic progress is sure to be in the direction of enabling each pound of copper to do a great deal more "work" than it now does.

As to the Free World outside the United States: The accompanying table shows roughly the per-capita consumption of electric energy in various areas during 1960 based on estimates of the Federal Power Commission.

Country	Per Capita Consumption —Kw-hr.
U.S.A.	1,000
Sweden, Norway, Canada, Switzerland	550
Great Britain, Australia, West Germany	210
Other "industrialized" countries	110
"Underdeveloped" countries	(?) 5-10

Now figures such as these are cited by those who forecast a phenomenal increase in copper consumption; and it must be agreed that if the countries outside the United States were to expand their rates of per-capita consumption of electricity to any-where near the current rate in the United States, future world demand for copper would exceed my forecast by a wide margin. The reasons for the high per-capita rate in the United States are two, each complementing the other: first, the widespread use for industrial and residential purposes requires motors, heating elements, and other equipment to consume the energy; and, second, this consumption in turn requires the equipment to generate and distribute the energy. Now my view is that it will be a long time before the rest of the world will even approach the "luxury" level of the United States in consuming electric energy. It may be conceded that the standard of living in the backward countries will advance—but this advance will be gradual and slow. It will be evidenced in many other ways before, for example, electric coffee percolators, electric blankets, and electric air-conditioning equipment are even considered in any substantial volume. Again it should be emphasized that the increase in per-capita consumption of copper need not by any means be at the same rate as contemporaneous per-capita consumption of electric energy in a given country.

In any event, on balance, I feel that my projection of copper demand beyond 1960 is reasonable. Admittedly, it is based in some measure, on hunch.

Secondary Copper—In Chart No. 1 the data are for newly-mined to the exclusion of "secondary" copper—that which has been used, has been salvaged, reclaimed, re-smelted and often refined for re-use. For practical purposes "secondary" copper is essentially an alternate for primary copper just as are aluminum, stainless steel, or plastics.

Producers of copper rightly point out its qualities of durability and resistance to corrosion, its property of indestructibility; but in one respect this excellent property is a boomerang. The same pound of copper eventually may be used 10 times!

Secondary copper (including alloys) is classified as "new" scrap and "old" scrap. "New" scrap is produced in the process of fabrication and is returned to the "circuit" so to speak, whereas "old" scrap is metal that has been salvaged after having been once used by industry. Only "old" scrap is significant. The quantity produced has varied widely. In the United States during the last 30 years it has ranged from 30 to as high as 55 percent of the total indicated consumption of newly-mined metal. The higher percentages prevailed during the depression years when mine production was low. In recent years it has averaged around 40 percent or about 470,000 tons per year. What generates "old" secondary of course, is the wearing out and the obsolescence of plant, facilities, equipment and, not to be overlooked, household gadgets. In the future, as the reservoir of useable copper grows, the tonnage, even if not the percent, of secondary copper will expand and consequently the demand for newly-mined copper will be much less than if copper were not "indestructible." That is one of the most significant factors in holding down my projection of future demand for newly-mined copper. By 1965 the supply of "old" secondary in the Free World may exceed 800,000 tons per year.

Table No. II

Estimated Copper Content of Known Deposits in the "Free" World Exploitable at a 30-Cent Market Price and Economic Conditions Existant in 1960[1]

COUNTRY	*SHORT TONS*
United States	45,800,000
Canada	12,200,000
Mexico & Cuba	1,700,000
South America	64,600,000
Europe	8,250,000
Africa	53,600,000
Australia & Asia	4,250,000
Total	190,300,000

[1] Sources: Annual Company Reports, Sundry Publications, and Private Communications.

from low grade, extensions of known ore, and new districts

tonnage of copper contained in known deposits and exploitable at a market price not exceeding 30 cents per pound (in 1960 dollars) using methods generally known and practiced in 1961. The total, 190,300,000 tons, is enough to supply 4,750,000 tons per year until A.D. 2000; and according to my forecast the demand will not reach that level until about 1968.

The exciting and significant point, however, is that potential expansion of known reserves is really tremendous. Avenues of such expansion will be discussed qualitatively and in general rather than in precise quantitative terms. They can be put in three categories; as follows:

(1) Conversion of presently known deposits from worthless rock into minable ore; (2) discovery of "new" ore as downward or lateral extensions of, or in the general vicinity of, known deposits; and

(3) discovery of ore deposits in areas that are virgin so far as copper mining is concerned. (In regions like the Western United States that have been well prospected these may be areas where surface indications of ore are entirely absent; in other regions they may be areas that simply have never been explored for copper.)

Category 1. The conversion of "rock" to "ore," is of course, based on economics. If the margin between the market price and the production cost at a particular deposit becomes adequate, the material becomes "ore." Before many years the trend of the price is certain to be upward! But, in the meantime there is reason to expect a modest decline in cost of producing copper from an ore of given character and grade. Again I am speaking in terms of 1960 dollars and assuming other economic conditions to be as they prevailed in 1960. A word of caution might be sounded here, however. Too much should not be expected of technologic progress in reducing per-pound costs. For example: 50 years ago only about 65 percent of the copper contained in a concentrating ore was recovered. Today the corresponding figure is close to 95 percent. Improved technology turned "rock" to "ore"; but when one recovers 95 percent or more there is not much more to work on because, even if it were technically possible, the cost of getting the last few percent probably would be more than the value of the additional metal.

Improved methods and equipment for drilling and blasting and the use of remarkably large and efficient earthmoving machinery, particularly in open-pit operations, have been phenominally effective in cutting mining costs. Even though a cost of 20 cents per ton has been achieved—as it frequently has—there remains room for further improvement. Even so, it should be noted that a point will be reached where the cost in man-hours will have neared rock-bottom.

Category 2. The discovery of "new" ore in and around "old" areas will result primarily from more intensive and more effective searching. Higher prices (and prospective higher prices) for copper will afford the incentive; and more money and more brains will be allocated to the business of finding ore. Improved and/or new techniques, methods, devices, instruments, and equipment will be employed. The arts of the geophysicist and the geochemist will be developed in scope and precision. One highly competent geophysicist tells me that if he had adequate financial backing (and he has in mind several millions of dollars) he could perfect instruments and methods that would probe the earth as thoroughly and obtain knowledge as accurate as exploration by diamond- or churn-drill—and at only a fraction of the cost! Even allowing for some over-exuberance the claim is significant.

A notable fact of mining history is that, although some sizable copper mines have been abandoned, only a handful of important copper-mining *districts* have died. Jerome in Arizona and Latouche-Kennecott in Alaska are among the few. An excellent place to look for copper is the neighborhood of existing mines; and one can be sure that more determined and sophisticated methods of search will find a lot of it.

Category 3. The third category of potential "new" copper deposits includes those that will be found in places where no one has ever looked for them in a serious way. As I already have suggested the Rocky Mountain region in the United States has been pretty well explored and prospected so that it is probable that most of the out-cropping deposits of any promise are known, even though some have not hitherto justified exploitation. Many of these eventually will become mines—predominantly, but not exclusively—big operations based on low-grade ore. Each of the important domestic copper-mining companies controls deposits, that it plans to exploit five, 10, or even 20 years from now.

In addition to these, however, geologists in general agree that there exist many large deposits that are unknown because they are completely hidden with covers of detrital material, lava flows, or rock of some other kind. Overall geological conditions over huge areas are favorable. Why, it may be asked, only one important district in Montana; one in Utah; one in New Mexico; two in Nevada and none at all in Idaho or Colorado?

Granting that 90 percent of the geologically favorable areas in the United States have been subjected to surface prospecting, corresponding percentages in other countries probably range from, say, 40 to as low as zero—which would describe the situation in Antarctica, for example. How about the other copper producing countries, particularly Canada, Africa, South America, and Australia?

An illustration of systematic and intensive exploration on a large scale is the work being done today in Northern Rhodesia by both the Rhodesian Selection Trust and Rhodesian Anglo-American groups. Concessions of huge area can be obtained that give exclusive prospecting privileges so that elaborate and carefully planned programs are justified.

In a report on the Seventh British Commonwealth Mining Congress (MINING WORLD—August 1961) a correspondent described a newly discovered massive "section 50 feet thick containing 19 percent copper" and extending—with some lean spots on the way—over "miles of strike length." The figures are reminiscent of the prospectuses of shady mine promoters 50 years ago; but they are real and not dreams. The report notes that the N'Changa West orebody contains more than 60,000,000 tons of proved ore that averages 6.36 percent copper. But the most significant fact is that in a district where there is so much high-grade there is bound to be many times as much low-grade ore.

In the Belgian Congo, to the north, the Union Minière du Haut Katanga is constantly finding new (and generally rich) ore deposits thereby steadily increasing its known reserves, that already are second only to those of Chile's Chuquicamata in the copper world today. Although not as sensational, because, the grade of ore usually is much lower, "new" finds in "new" territory are being made constantly in Canada, Chile, Peru, Australia, and elsewhere.

In preparing the figures in Table No. I, I listed by name the important properties now operating or projected for operation by the end of 1965; and for each set down an estimated tonnage and grade of ore to arrive at the quantity of contained copper remaining either at the end of 1960 or at the date of the most recent officially published estimate of reserves. For mines in the United States these often went back to the mid 1950's, or earlier. In some instances no figures were avail-

"I have a feeling that a radical change in the conduct of

On Chart No. 2 are plotted average domestic refinery prices in cents per pound (E&MJ) from 1913 to 1960 inclusive. They have all been computed in 1960 dollars to remove the element of inflation. For the same reason my projected range in price from 1962 to 2000 assumes a constant dollar.

Perhaps the outstanding feature of the historical record is the wide and comparatively rapid fluctuation in the price. It has been vulnerable to war, depression, and boom. During World War II the government froze the price at 11.775 cents per pound; and thereby, no doubt, avoided a sharp upswing. Among the reasons for the erratic behavior of the price a few may be mentioned.

1. Copper futures are much used as a medium for speculation on the London Metal Exchange. People who would not know a wire bar from a Fleet Street "pub" buy and sell copper. With or without sound reason, the New York market has tended to follow the London market. The latter has led the price up—and it has led the price down.

2. Important industrial consumers in the United States have been prone, probably against their own best interest in the long run, to "play" the copper market. When the market has been buoyant and price high they have over-bought against the contingency of still higher prices. When prices have been low and the market stagnant they have shunned the metal in hope of still lower prices. By so doing they have accentuated the swings.

3. The existence of custom-smelting companies, that too often have felt obliged to sell each week the equivalent of their current intake, has had the effect of driving down the price in a weak market.

4. The facts that many companies in many countries have contributed to the world supply; and that the market is world-wide in character, as I already have mentioned, are factors.

5. Primarily because of the wide variation in the grade of ore at different mines direct production costs may vary from, say, 16 to 26 cents per pound. Contrast this with the cost of producing aluminum. If one company can make aluminum for 20 cents per pound any large and well managed company can come close to that cost. Consequently, their interests closely coincide as contrasted to the seeming conflicting interests of high-cost and low-

able and I was obliged to make an estimate based on such data as are obtainable—usually from published sources: books, brochures, and periodicals. Sometimes the data came from private communications or from discussions with geologists and others in a position to know the facts.

These same sources were used to obtain information for "adjusting" the individual figures. Most of the adjustments were upward because official "ore reserves" typically, are estimates of the minimum quantities that surely will be mined. Valuation by taxing authorities is a consideration in publishing ore reserves. Significantly the final figures do *not* represent a uniform percentage increase. They are to an extent conjectural, but they are based on more than whim. The geology of the deposit; and the rated capacity of the production facilities are keys to the size of the reserves.

Summing the revised figures according to geography results in Table No. 1 showing in the aggregate 190,300,000 tons. The Chart purports to reflect the quantity of copper contained in deposits that have been proved and that could be mined profitably at production costs prevailing in 1960 and with a market price not exceeding 30 cents per pound. It takes no account of the new resources that I have described under Category Nos. 1, 2, and 3. If my thesis is correct, *at least* 190,000,000 tons still will be available for mining at the end of A.D. 2000—at costs and prices prevailing at that time.

Equipped Capacity—However, copper in the ground is not like money on deposit in the bank—withdrawable at any time in any amount. To turn copper in the ground into refined wire-bars is a long, complex, and costly procedure. The investment in facilities and plant is large and it becomes larger per pound of copper to be produced as the average grade of the ore declines. Moreover, it takes time, running into years, to prepare an ore deposit for large-scale mining operations and to build necessary plant and facilities. For these reasons equipped capacity is a second vital element in the ability of the copper mining industry to meet the demand.

CONCLUSIONS AND CONJECTURES

To sum up briefly, I offer these conjectures as to the state of the copper-mining industry in A.D. 2000:

1. **The Free World will consume somewhat less than 7,000,000 tons per annum of newly-mined copper and around 1,750,000 tons of "old" secondary.**
2. **An overwhelming proportion of the copper consumed will be used because of its property of high electrical conductivity.**
3. **Copper will have retained its pre-eminence as a conducting material for electric energy; but brass and bronze will be sorely pressed by competition from alternate materials.**
4. **Africa will rank first among the continents in the quantity of output; and North and South America will be in a close race for second place.**
5. **The world price will be equivalent to a United States refinery price in the range of 40 to 48 cents per pound. (In 1960 dollars.)**
6. **Known reserves of copper in the ground will be at least as great in the aggregate as they are in 1961, (190,000,000 tons) thanks to the costly but generous use of highly sophisticated methods, instruments, and equipment for exploration. They will include ores containing 0.4 percent copper—or even less.**
7. **Officials of copper-mining companies, as a group, will bask in the glow of approbation of well contented shareholders.**

As a matter of fact, equipped capacity is a flexible term when expressed in pounds of copper. Usually (particularly in open-pit operations) the limiting factor in tons of ore mined and treated is the capacity of concentrating, leaching, or smelting facilities. Consequently, the capacity of copper depends on the grade of the ore treated. For example Kennecott Copper Corporation's Utah Copper Division actually produced 248,000 tons of metal in 1956; but the rated equipped capacity in 1961 is about 236,000 tons. The shrinkage is due entirely to the lower average grade of the ore reserves; for, normally, it is not good business—even when physically feasible—to mine ore richer than the average of the reserves.

In Table No. 2 I have shown for each of the more important mines in tons of copper 1. Actual output in the best year since 1955; 2. An estimate of the equipped capacity at the end of 1961; and 3. A similar estimate for the end of 1965. The data for 2 and 3 are official or "semi-official" taking into account only construction or expansion definitely projected.

In passing it may be noted that the largest proportionate expansion, 1956 vis-a-vis 1961, is in Africa—23 percent. South America is second with 21 percent, and the United States, the other of the "big three," is only six percent. Even so, until 1965 at least, the United States will retain first place in aggregate capacity—1,483,000 tons compared with 1,381,000 for Africa, and 1,105,000 for South America.

The aggregate amounts—4,501,000 and 5,159,000 tons for 1961 and 1965 respectively—are shown graphically by the vertical bars on Chart No. 1. They indicate a substantial excess of capacity over the expectable demand for each year. This excess is desirable because it is not expected that all properties can produce at their full maximum capacity in a given year. Less than-maximum output can result from various difficulties not the least of which may be labor strikes. Looking ahead beyond 1965 there is no reason to doubt that the copper industry as a whole will expand its production facilities in advance of the probable demand for its product. As already has been argued the supply of ore in the ground is certainly sufficient to meet requirements well beyond A.D. 2000. This adequacy of ore and of production facilities, of course, bears on the next topic—the future market price for the metal.

the business of mining and marketing copper is underway"

cost copper producers.

But, one major reason for the wide fluctuation, related in part to the foregoing, has been the absence (except for a few desultory and abortive episodes) of any effort to "administer" the price of copper. Contrast the erratic price curve for copper with the lethargic curve for aluminum, by way of example.

However, I have a feeling that a radical change in the conduct of the business of mining and marketing copper is underway; and I suspect that it will gain general acceptance and become a fixture. The experience of 1955 and 1956, when for 10 months the average price continuously exceeded 40 and ranged above 47 cents awoke all copper producers to some of the facts of life—facts that many of them had sensed all along. The high prices aggravated industrial consumers (who, as I have pointed out were not entirely without contributory guilt) and stimulated plans for the use (as well as actual substitution) of alternate materials for many purposes. Few of the big producers were happy, despite some exceedingly fancy earnings statements generated by the high price.

I am convinced that the major factors in the industry are going to seek a reasonable degree of "stabilization" in the copper market; and by that I do not mean that they are going to combine or work in concert to get an exhorbitant price—too often the connotation of "Stabilization."

It is my opinion that 85 percent of the copper currently being produced costs less than 26 cents per pound and that 50 percent costs less than 18 per pound.

In each case the cost of all steps, from exploration to marketing, is included as well as depreciation and ordinary taxes. Depletion, export duties, royalties, and taxes based on income are excluded.

A word as to costs may be in order. Many companies that formerly published their production costs in cents per pound have discontinued the practice; and because of wide diversity of activities it is not always easy to compute a cost figure from data in the published annual reports. Nevertheless, a knowledge of the geographic location and the nature of the deposit; of the copper content and other salient characteristics of the ore, enables one to make comparison with

continued on page 59

HOW FLOTATION makes high-grade

HUMBOLDT MINING COMPANY FACTS

Ownership: Jointly by Ford Motor Company and Cleveland-Cliffs Iron Company. Technical management by Cliffs.

Location: On Marquette Iron Range 14 miles west of Ishpeming, Michigan.

Ore: Low-grade mixture of cherty specular hematite and magnetite with minor martite and sericite.

Pelletizing: Reground concentrate and bentonite are mixed and balled in drum to form green pellets.

Heat hardening of pellets: A three-step process to dry and indurate, fire for strength, and cool while reclaiming heat.

Heat hardening equipment: The Allis-Chalmers grate kiln process which uses a chain type grate, a rotary kiln, and a counter current flow annular cooler.

By Robert W. Berkhahn, operating metallurgist, Humboldt mine Cleveland-Cliffs Iron Company.

Mr. Berkhahn, a graduate metallurgical engineer from the Michigan College of Mining & Technology has worked for the Humboldt Mining Company as operating metallurgist since 1955.

Humboldt Mining Company, the pioneer of iron ore flotation in Michigan, has been expanding its mining and beneficiation plant since the first unit went into operation in 1954. Today the company operates completely integrated low-grade-ore to high-quality-pellet plants, to produce a very high grade iron pellet with superior physical and structural properties that finds wide acceptance by blast furnace operators.

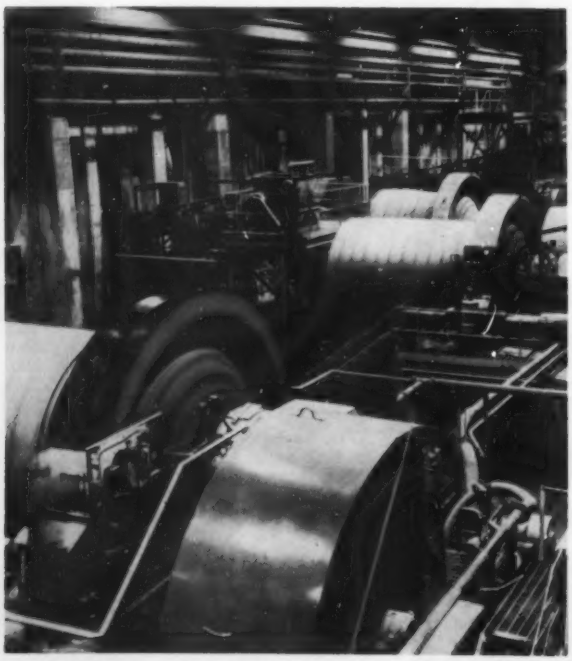
The expanded crushing and flotation plants and the new pelletizing plant went into operation in July 1960 to produce 2,000 long tons of pellets per day.

This article describes the mining and concentrating operations. The pelletizing plant was described in the October issue of MINING WORLD by Mr. D. M. Urich, pages 16 through 21.

The concentration of specular hematite using the flotation process began at Humboldt in 1954 with the completion of a mill which produced approximately 650 long tons of concentrate per day. Subsequent equipment additions to the mill in 1954 and 1955 increased the plant capacity to approximately 1,000 long tons of concentrate per day. This final product, having a consistency too fine for use in the blast furnace, was sintered at the Rouge, Michigan Steel plant of the Ford Motor Company.

In 1958 design work began on the expansion to the crushing and concentrating facilities and construction started in the spring of 1959. The design and construction of these facilities was handled by the Western Knapp Engineering Company of San Francisco, California.

The expansion included the addition of one tertiary crusher, and associated equipment, one complete mill unit, and a regrind section for regrinding the flotation



GRINDING is two-stage. Ball and rod mills with a hydroscillator between stages. Tricone ball mill feed is plus-65-mesh.

Hydroscillator in grinding

The crushing of the crude cherty ore to a suitable size for feed to rod mills is accomplished by three stages of crushing. The ore is dumped into a 48-inch gyratory crusher for reduction to minus-6½-inches, with the crushed ore discharging into a surge hopper below the crusher. The crushed ore is withdrawn from the surge hopper by a 48-inch pan feeder to a belt conveyor transporting the ore to the secondary and tertiary crushing building. The ore is discharged from the conveyor onto a double-deck vibrating screen which separates the plus-2-inch material from that under 2-inches in size. The oversize material (plus-2-inch) from the screen is fed to a 7-foot secondary cone crusher which reduces it to minus-2-inch in size. The undersize material (minus-2-inch) from the vibrating screen and the product of the secondary crusher combine on a conveyor underneath the crusher and are conveyed to a 200-ton surge bin. The ore is drawn from this bin and fed to two double-deck vibrating screens. The oversize (plus-½-inch) from these two screens feeds, by gravity, two 7-foot tertiary crushers. The discharge from the crushers, and the undersize, (minus-½-inch) from the two screens combines on a conveyor underneath the tertiary crushers and are conveyed to three 2,000-ton capacity fine ore bins which are adjacent to the concentrator building.

Crushing plant operation is scheduled for day shift, seven days a week. The average hourly feed rate through

specular hematite concentrate at Humboldt

Part II of II

concentrate prior to pelletizing. The addition of a scavenger line in each flotation circuit was the only basic flowsheet change.

In addition to the open pit mining there are five major steps in the processing of the crude ore. They are: 1. crushing, 2. grinding and desliming, 3. conditioning and flotation, 4. filtering, and 5. regrinding.

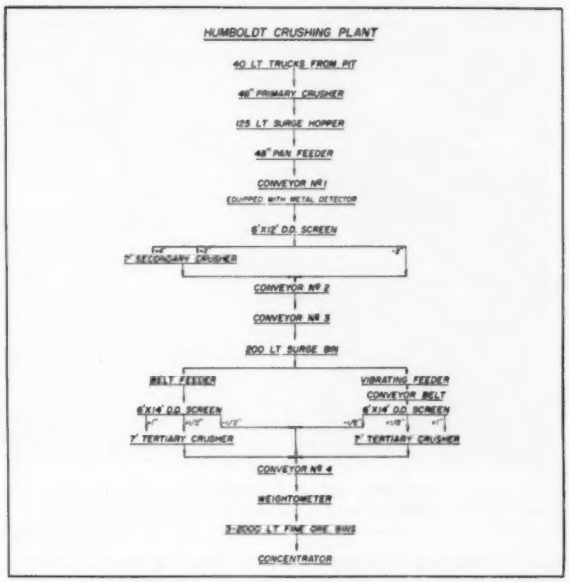
The concentrator operates on a 21 shift per week schedule. Plant unit repairs are scheduled in accordance with the preventive maintenance system. Generally, each unit is shut down for repairs every eight to 10 days.

Humboldt crude ore is a low grade mixture of cherty specular hematite and magntite with minor martite and sericite. The iron oxides occur as bands of varying thickness in the chert and in some areas the oxide mineralization is extremely fine grained and is disseminated throughout the chert bands. The overburden covering the ore body varies in depth from bare outcrops to 50 feet at some points in the pit and in character from fine sand to massive boulders.

Primary ore drilling is done by jet piercing, supplemented by a rotary drill using 9-inch carbide Tricone bits in softer portions of the ore body. The rotary drill is used primarily for drilling rock for rock stripping.

Ammonium nitrate prills is the primary blasting agent. Flogel is used along with the prills where necessary due to pit water conditions. Secondary breakage is accomplished by a drop-ball crane, utilizing a 5-ton NiHard drop-ball.

Broken ore is loaded by electric shovels equipped with 5-cubic-yard buckets into 40-ton Diesel-powered trucks for haulage to the crushing plant. Electric shovels with



2½ to 4-cubic-yard buckets are used for stripping, stockpile loading, and general utility work.

The pit operates on a seven-day, three-shift-per-day schedule. The ore haulage is accomplished on day shift, seven days per week with the stripping work being done on a three-shift basis, seven days a week.

circuit; deslime in cyclones

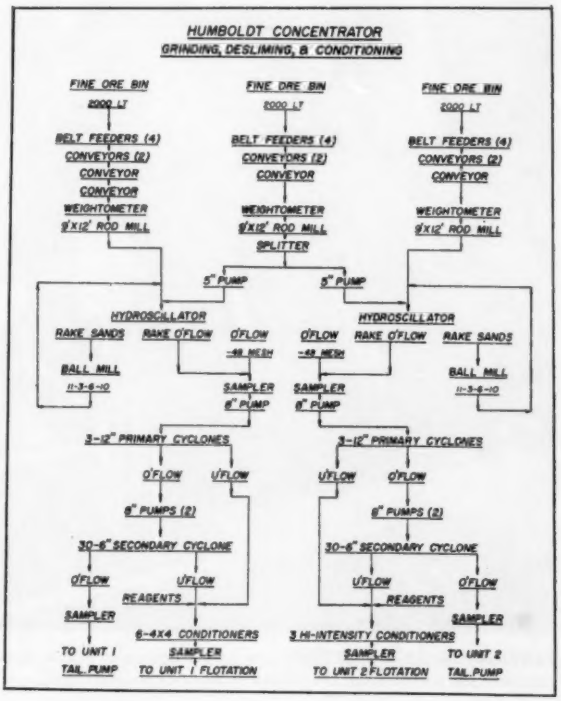
the crushing plant is slightly over 600 long tons, with the operation peaking at 700 per hour.

The grinding section consists of three 9 by 12-foot rod mills and two hydroscillators in closed circuit with two 11–3 by 6–10 Tricone ball mills. Each of the grinding mills is driven by a 450 horsepower sychrononus motor.

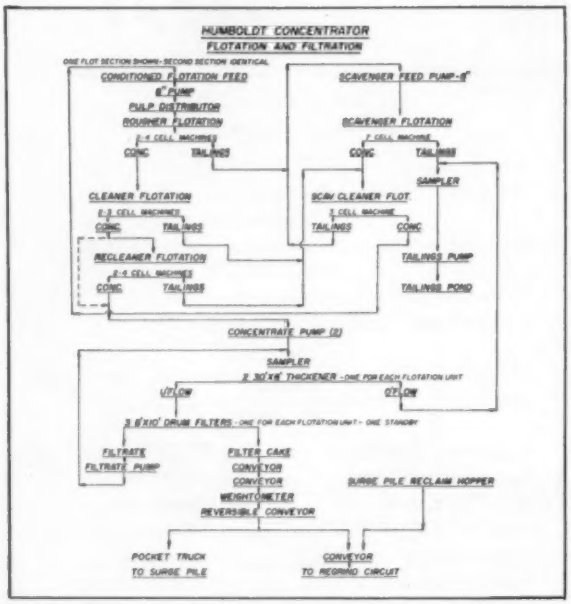
Crude mill feed is drawn from four openings in the bottom of each fine ore bin by belt feeders and transported to the rod mills by a conveyor belt. The ore is reduced to approximately eight mesh in the rod mills and the product of one and one half rod mills is discharged into each hydroscillator. The plus-65-mesh material is fed into the ball mill for futher reduction. The ball mill product returns by gravity to the hydroscillator. The hydroscillator overflow, or minus-65-mesh material, is pumped to cyclones for desliming and thickening.

The desliming circuit consists of three 12-inch primary cyclones and 30 6-inch secondary cyclones in each of the two units. The hydroscillator overflow is pumped into the primary cyclones with the cyclone underflow going to the conditioners and the overflow is pumped to the secondary cyclones. The underflow from the secondary cyclones also goes to the conditioners and the overflow is a final tailing. The secondary overflow represents 3 to 4 percent by weight, of the crude mill feed and 2 to 3 percent of the total iron units.

please turn page



Vigorous conditioning precedes flotation using tall oil to recover



FLOTATION and filtration flowsheet showing new scavenger units which have materially improved recovery.

The purpose of conditioning is to secure proper contact of the flotation reagents with the iron mineral particles. Conditioning is performed at approximately 70 percent solids. The conditioners in Unit No. 1 are six 20 horsepower 4 by 4 foot units with 24-inch propellers. Unit No. 2 conditioners consist of three high intensity units with turbine type propellers, each equipped with a 50 horsepower motor.

The reagents are shown in Table No. I. The conditioned pulp flows by gravity to the rougher flotation feed pump, which feeds a two-way pulp distributor.

The flotation circuit is identical in each unit with two 4-cell rougher machines, two 3-cell cleaner machines, two 4-cell recleaner machines, a 7-cell scavenger machine, and a 3-cell scavenger cleaner machine in each unit. The flotation machines are arranged in a step design to permit the gravity flow of concentrates between the roughing, cleaning, and recleaning stages. The rougher tailing from the two rougher machines is combined and pumped to the 7-cell scavenger machine, where a scavenger concentrate and the final flotation tailing are produced. The scavenger concentrate plus the cleaner and recleaner tailing flow through a pumper cell to the 3-cell scavenger cleaner machine. This machine produces a concentrate which is returned to the head of the roughing circuit and a tailing which goes back to the 7-cell scavenger machine.

Prior to plant expansion in 1960, the flotation circuit consisted of three lines of roughers, cleaners, and re-

Concentrate regrinding to 75 to 80 percent minus-325-mesh



REGRINDING AND FILTERING are key steps to produce concentrate for pelletizing. Disc filter in front of regrind mill.

The purpose of the regrind section is to regrind the flotation concentrate to a size which will permit the formation of a green ball of adequate strength to withstand the necessary handling prior to being hardened in the grate-kiln system.

Equipment in this section consists of belt feeders, feed conveyors, two 10.5 by 16-foot ball mills each driven by a 900 horsepower synchronous motor, three 6 foot by 8 disc filters (one as spare), filtrate pumps, a two stage vacuum pump, and a conveyor system which transports the reground filter cake to the pellet plant storage bins.

The flotation concentrate varies in fineness from 40 to 45 percent minus-325-mesh, depending on the type of mineralization in the crude ore. Pilot plant work indicated the need of a fineness of reground concentrate ranging from 75 percent to 80 percent minus-325-mesh for proper operation of the pelletizing system. The fine regrind requirement has also been true of the commercial plant operation.

Grinding is in open circuit so it is necessary that frequent samples of regrind mill discharge be taken for close control of the product. In practice, samples are taken every four hours for screen analysis and the regrind operator adjusts the feed rate accordingly.

Moisture control of the regrind filter cake is as important as concentrate fineness. Filter cake moisture samples are taken every two hours to assure the desired moisture content, which is the range of 9.5 to 10.0 percent moisture.

A reclamation system for the pellet plant fines is also incorporated in the regrind section. Grate drippings and cyclone solids are collected in the pellet plant, pulped, and pumped to the regrind section. This material is pumped to four 4-inch cyclones. Cyclone underflow is fed into the regrind ball mills and the cyclone overflow

85 percent of iron in 62.5 percent concentrate

cleaners. The incorporation of the scavenger line in each flotation unit has materially improved the iron unit recovery with an increase in concentrate grade. The concentrate grade averages 62.50 percent iron with an 8.80 percent silica. The iron unit recovery is in the range of 81 to 85 percent depending on the type of iron mineralization.

Gravity flow of the concentrate froth from the roughers through the recleaners has completely eliminated the troublesome froth pumping problem which formerly existed when all of the flotation machines were on the same level.

The final concentrate is pumped to a 30 by 8-foot thickener in each unit.

Filtering

The primary filter section consists of three 10 by 8-foot drum filters with associated filtrate and vacuum pumps. Two of the drum filters are in use at all times with the third used as a standby. Centrifugal pumps are used to pump the thickened concentrate from the thickener to the filters. The filter cake averages 6.50 percent moisture, and is transported by a conveyor system to a 2,700-long-ton storage bin ahead of the regrind mills, or to a truck pocket for haulage to a concentrate surge pile. The stockpiled material can be reclaimed as required by use of a front end loader which dumps into a reclaim hopper feeding the conveyor belt which transports the concentrate to the regrind storage bin.

is key to good pelletizing

is used for regrind mill dilution water and filter makeup water.

The Humboldt operation requires approximately 6,200 gallons per minute of water. Fresh water requirement totals 2,800 which is obtained from nearby lakes.

The addition of the concentrate regrind and the pelletizing facilities at the Humboldt mine has changed the concept of the concentrator operation. Formerly, the concentrator was producing a final product. Now the concentrator can be considered as a feed preparation section for the pelletizing facilities. In particular, much closer control of the primary grind is imperative in order to deliver concentrate of sufficient fineness to the regrind section and then to the pellet plant for proper operation at peak capacity. On some types of crude ore this actually means overgrinding from the standpoint of liberation. The finer grinding has proved slightly beneficial on most types of ore from the standpoint of concentrate grade and iron unit recovery. The overall effect of the finer grind has been a more efficient metallurgical process with a slightly negative effect on concentrate production rates and higher grinding costs. The installation of additional primary grinding capacity is being considered at this time to increase concentrate production rates.

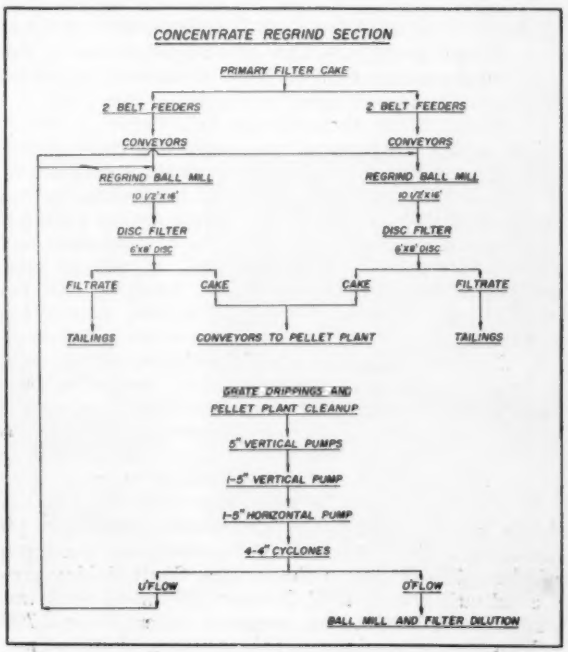
Present planning and test work is being centered on the installation of automatic controls in the various crushing and milling circuits. It appears that automatic systems can be developed which will reduce manpower requirements. Other controls which are being developed will help the plant operators maintain better control of plant circuits and should improve present production rates. The automation and instrumentation of the various plant circuits offers an effective means of combating the ever-present problem of higher operating costs. END.



FLOTATION CIRCUIT now incorporates rougher, cleaner, recleaner, and scavenger stages with gravity flow of froth between stages.

Table No. I
Humboldt Mining Company's Iron Ore Flotation Reagents

Reagent	*Pounds per Ton of Feed*	*Point Introduced into Circuit*
Aerosol	0.005	Primary cyclone underflow
Tall oil	1.0	No. 1 conditioner
Tall oil	0.5	Last conditioner
Frother	0.05	Last conditioner



BANNER prepares to mine richer ores shaft and initial development

With over 60,000,000 tons of total copper ores available, it is no wonder Banner Mining Company is pushing development of Palo Verde mine

Mr. Allan B. Bowman, vice president and general manager of Banner Mining Company, is keeping himself busy these days getting ready for coming production from Banner's newest mine—the Palo Verde. This deep underground operation will soon be producing over 1,000 tons of copper ore a day. In the meantime, ore from deep development headings is being hoisted at a rate of 500 tons a day, the shaft is being deepened from 960 feet to 1,020 feet; and to handle this harder ore, the Mineral Hill mill is being revamped and its capacity increased. Serious consideration is also being given to future open pitting of the Palo Verde mine. Open pitting will eventually be the cheapest and most practical way to mine the many millions of tons of low grade ore located above a depth of 700 feet from the surface. Remember, diamond drilling is still delineating the shape and size of this ore body, which is still open and undrilled on three sides. So, just how and when all Palo Verde ore will eventually be recovered is a question to be answered in the future, but for the present, Allan Bowman and his staff have a full schedule. Here is the latest report about Banner's activities south of Tucson, Arizona.

The Palo Verde ore body is in the Mineral Hill mining district and adjoins the properties of the American Smelting & Refining Company. It is considered to be an extension of the Mission ore body now being developed by ASARCO.

The discovery of the Palo Verde was the result of geological and some geophysical methods of exploration plus follow-up drilling. The encouraging results of this preliminary work led to a program of diamond and churn drilling that has continued intermittently ever since.

Exploration has disclosed that Palo Verde ore occurs disseminated in arkose and graywacke type rocks, as well as in the shear zones and as replacements of sedimentary rocks that have been metamorphosed to hornfels, tactites, and marbles. Chalcopyrite and bornite are the principal ore minerals, with smaller amounts of chalcocite and tetrahedrite present. Traces of gold, as well as some silver and molybdenum are found. Leaching and enrichment of copper is negligible. To date, Banner has drilled the orebody on 250-foot centers north and south for 1,320 feet, and a distance of 2,500 feet east and west.

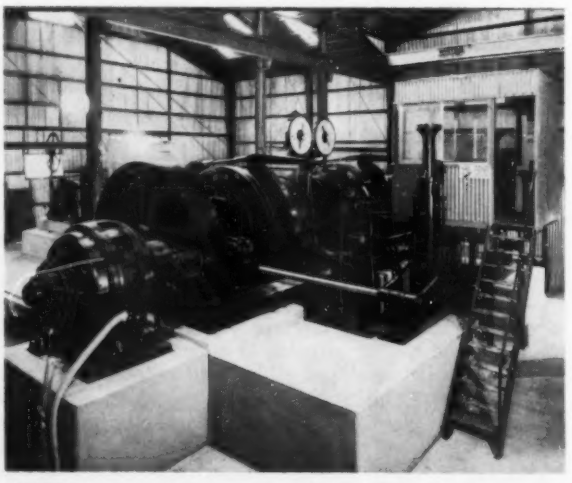
In November 1959, a contract was given to the Centennial Development Company of Eureka, Utah, to sink a five-compartment shaft. The purpose of this shaft was to develop and mine the deeper, higher grade portions of the ore body that could not be mined by future open pit methods. These richer ores occur from about 650 to 1,200 feet below the surface. The lower grade open pit ore occurs under 200 feet of overburden, down to a depth of about 700 feet from the surface. Shaft sinking progressed satisfactorily until October 1960 when work was stopped at 960 feet due to excess water. Over 2,700 gallons of water a minute were being pumped at the time, and the shaft was flooded out up to the 400 level.

Water problems had been anticipated earlier, and every effort had been made to lower the 300 foot water table before shaft sinking started. Some 30 feet south of the shaft, a 20-inch borehole was drilled to a depth of 1,200 feet, cased, and a Byron-Jackson submersible pump installed. It was hoped that this would de-water ahead of shaft sinking. However, at a depth of 400 feet the shaft met the depressed water table but practically no water seaped into the shaft from the borehole. Apparently the main water flow was coming into the borehole from a much greater depth. Shaft sinking continued to 960 feet under practically dry conditions at which point the large influx of 2,700 gallons per minute stopped all work. A second 28-inch borehole was drilled 900 feet east of the shaft for future ventilation purposes. This hole was cased the entire depth of 700 feet, and was put to use after a second Byron-Jackson submersible pump was installed therein to facilitate dewatering.

Pumping continued, though, and by April 1961, the water table had been lowered to well below the 960-foot shaft bottom. By this time the water inflow was only about 550 gallons per minute, and was easily handled by the single submersible pump in the closest borehole. In June, work on deepening the shaft to the planned 1,020 foot depth was resumed by Centennial Development Company.

The 11- by 20-foot rectangular shaft, with steel shaft sets, is concreted for the first 400 feet below the collar. It has two compartments for ore skips, a man-supply cage, laddered manway, and a compartment for pipe, cables and counterweights. The five ton, counter-balanced bottom dump skips, made by Vulcan Iron Works Company, run on mahogany guides as does the man-supply cage.

The all-steel headframe, 120 feet high, was erected by Banner. A 500-ton ore bin and 250-ton waste bin, built and erected by Allison Steel Company of Phoenix, are



HOIST for man-supply cage is a Wellman-Seaver-Morgan unit still in top condition after many years of service.

as Palo Verde nears completion

attached to the headframe. Ore and waste from the bins are fed into trucks by National Iron Company Hydra-stroke reciprocating feeders.

The hoist and compressor buildings are made of prefabricated corrugated steel, built and erected by Acme Steel Company of Phoenix. The man-supply cage is hoisted by a 375-horespower Wellman-Seaver-Morgan hoist, and the ore-waste skips by a 400-horsepower Nordberg double-drum hoist. In the compressor building, two 175 horsepower Worthington's and one 300 horsepower Chicago Pneumatic compressor supply over 3,000 cubic feet of capacity a minute. A change house and mine office building made of concrete block complete the surface facilities.

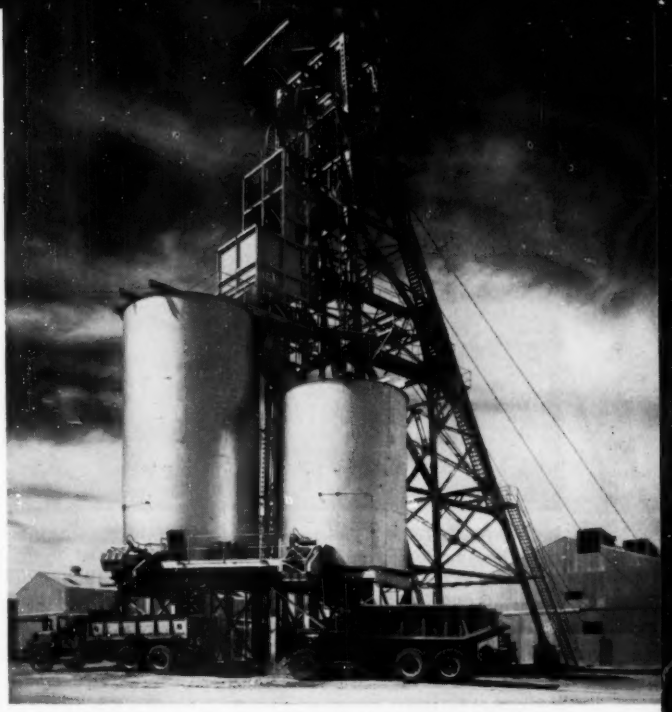
Underground development of the Palo Verde mine is being done entirely by Banner. Shaft stations, as well as 200-ton ore and waste pockets, have been cut on the 700, 800, and 900 levels. Drifting on the 700 and 800 levels now totals several hundred feet. Since the hard tactite stands well, timber sets are used for support at shaft stations only. For safety, though, rock bolts and chain link fence are used in all the haulage drifts.

For emergency escapeway a 42-inch churn drill hole has been put down to the 700 Level. It has been cased to 38-inch inside diameter, and equipped with ladder and landings. A second churn drill hole (30 inches in diameter) serves as an exhause vent.

Mining equipment underground includes Gardner-Denver air feet leg drills, crawler-mounted Ingersoll-Rand Boom drilling rigs, three crawler mounted Eimco 630 excavators, and one track-mounted Eimco 21 loader. Haulage is done with 30 C.S. Card three-ton self-dumping Granby type cars pulled by two Greensburg four-ton battery locomotives on 24-inch gauge 40-pound track. Shaft sinking has been done with a Cryderman Shaft Sinker.

Production from the development headings now totals about 500 tons per day, and by the end of this year should increase to over 1000 tons per day. This is output of three shifts a day with a total of 60 men underground. B. W. Venable is general mine superintendent, A. P. Holzworth is mine foreman, and E. E. Bray is master mechanic.

Development ore from Palo Verde operations is hauled on contract one mile to the Mineral Hill mill in 20 and 25 ton trucks belonging to M. C. Hubbell. Here at the mill, Frank Horton, mill superintendent, is revamping his operation to handle the harder Palo Verde ore. Three stage crushing has been introduced (instead of the previous two) by installing a four-foot Symons short head cone crusher. Ball mill capacity has been increased one-third by lengthening two Marcy 8-by 6-foot mills to 8-by 8-foot mills by inserting a two foot "ring" in the center of the grinding drums. A new bank of fifteen 56-inch Fagergren flotation cells have been added, as well as a new six-foot four-disc Eimco filter END



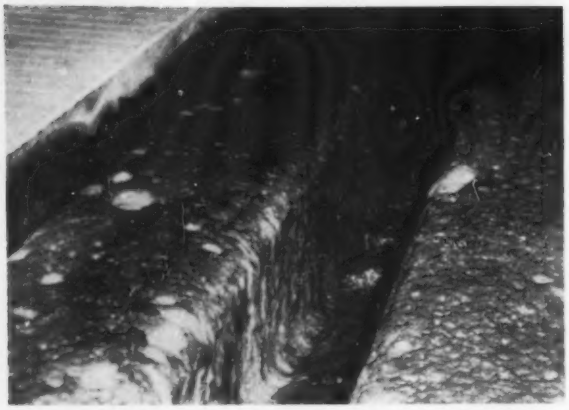
HEADFRAME at five-compartment Palo Verde shaft is 120 feet high with 500-ton ore and 250-ton waste bins attached.



MINERAL HILL flotation mill, one mile from the shaft, is being revamped to handle over 1,000 tons a day of the harder Palo Verde copper ore.



"RING" insert in center of ball mill increases grinding capacity one third.



FROTH FLOTATION as pictured here at an Arizona copper mine has made the recovery of millions of tons of copper possible. In the United States alone more than 150,000,000 tons of copper ore is treated by flotation every year. Copper is by far the largest user and benefactor of the miracle of flotation—new at 50 years.



FUTURE OF FLOTATION was featured by speakers. From left Dr. Luigi Usoni, Rome, Italy; R. Bhappu, New Mexico Bureau of Mines; P. F. Allen, Phelps Dodge Corporation; A. M. Gaudin, Massachusetts Institute of Technology; Norman Weiss, American Smelting and Refining Company; and D. W. McGlashan, Montana School of Mines.

FROTH FLOTATION—miracle of the metallurgical

"Flotation is not old at 50 years. There are still some beginnings in flotation directions" were the first words spoken at the first technical session of the Golden Jubilee celebration of flotation in the United States. "This direction is microorganisms" reported one of flotation's best known research scientists, A. M. (Tony) Gaudin, Richards Professor of Mineral Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts.

The important part that flotation has played in the metallurgical world was outlined some 23 technical papers later by Frank R. Milliken, president of the Kennecott Copper Corporation. He said that flotation and smelting rank with the most important of man's inventions and discoveries. No other developments have been responsible for such an increase in minerals production. Smelting, 5,000 years old, has been matched in importance by flotation developments in only 50 years, he said. Mr. Milliken outlined flotation's importance to civilization as he said, "Flotation has permitted the mining of low-grade and complex ores which would have been worthless if it had been necessary to rely on the time-honored method of gravity concentration."

Celebration chairman J. D. Vincent, of the 50th anniversary committee of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. announced that it was the 1911 "first use" in the United States of froth flotation at the Butte and Superior Company's copper-zinc mill at Butte, Montana that was being celebrated.

Flotation's Pioneers Honored

Both United States and Canadian old timers, and pioneers, as well as today's leading flotation metallurgists were honored at the welcoming luncheon. Chairman Harry McNeil asked the industry to pay tribute to the following men—both those in the room and those unable to attend—for making flotation such an important part of mineral dressing. They are listed alphabetically not in the order of introduction.

William Coghill for his many years of research for the U. S. Bureau of Mines.

Arthur Damon, pioneer builder of complete flotation units.

Ralph W. Diamond for lead-zinc flotation developments in Canada.

Fred DeVaney, metallurgist for Pickands-Mather & Company.

A. W. Fahrenwald, inventor of the "Sub-A" cell and a noted educator.

Anthony Gaudin for his writing and teaching.

George Griswold for first use of cyanide as flotation reagent at Butte and Superior.

W. Hirschkind for his work in developing xanthate at the Great Western Chemical Company.

Oscar Johnson for his work in grinding to prepare minerals for flotation.

W. B. Kramer, an old timer who first used flotation at the Old Dominion mine in Arizona in 1913.

Frank McQuiston, designer and builder of mills from Algiers to Washington state.

Arthur Taggert the author of the classic "Taggert's Metallurgy."

Clarence Thom whose flotation work started in 1917 with Consolidated Mining and Smelting Company in Canada.

Norman Weiss, chief milling engineer for ASARCO, designer of the Deming, Van Stone, Toquepalla, Keystone, Silver Bell, Mission, and Mt Isa (new) mills.

Frank Wickes, mill superintendent at Butte and Superior during initial flotation there.

Carl Williams who worked for Minerals Separation Corporation in 1916.

W. L. Ziegler, who first worked with flotation in 1911 at the Mt. Steven Syndicate and Silver Dollar mills.

How It All Began

Many legends and some literature contain reports on the invention of flotation. Most certainly Broken Hill, Australia was important for many of the significant beginnings. T. A. Read, C. W. Thompson, and K. P. W. Parsons of Broken Hill in their paper, "The Development of Flotation For the Treatment of Lead-Silver-Zinc Ores at Broken Hill, New South Wales, Australia" listed nine froth flotation milestones.



KINETICS OF FLOTATION was discussed by this group. Several read papers for authors unable to attend. Speakers are W. E. Guay; M. A. Cook, University of Utah; P. R. Stewart, Shell Oil Company; E. H. Rose, Koppers Company, Inc.; and session chairman W. B. Stephenson, Allan Sherman Hoff Pump Company.



SPECIALIZED SUBJECT speakers were Dr. P. O. Yingst, Colorado School of Mines Research Foundation; M. E. Volin, Michigan College of Mining and Technology; B. H. Clemmons; J. J. Bean, Miami Copper Company; O. W. Walvoord, O. W. Walvoord, Inc.; and Frank Windolph of Climax Molybdenum Company who was chairman of this special section.

world—with new horizons ahead at 50th birthday

1. Charles V. Potter process, 1901.
2. G. D. Delprat process, 1902.
3. Cattermole process, 1903.
4. Elmore vacuum process, 1904.
5. Mineral Separation process, 1905.
6. James Lyster differential flotation, 1912.
7. L. Bradford sulfite and SO_2 process, 1912.
8. L. Bradford soluble copper salt process, 1913.
9. Keller and Lewis of San Francisco, California "Xanthate" process, 1923.

How Molybdenum is Floated

R. W. Hernlund, chief metallurgist, Pima Mining Company, Tucson, Arizona gave a very complete and scholarly report on recovery of molybdenite from copper flotation concentrates. He reported that the United States molybdenite byproduct producers use an art and a science—froth flotation—to make an optimum recovery of only 200 parts of molybdenite from some 1,000,000 parts of crude ore. Today 10 mills treat 96,000,000 tons of ore to produce 2,520,000 tons of copper-molybdenite concentrate assaying, on average, 30 percent copper and 0.50 to 0.90 molybdenite. Concentrate then obtained by retreatment contains 85 to 90 percent molybdenite and 1.0 copper. Mr. Hernlund examined in detail the four individual phases of current plant practices. 1. Factors affecting molybdenite metallurgy in the copper flotation circuit. 2. The basic methods of separating molybdenite from copper sulphides. 3. Upgrading the molybdenite rougher product, and 4. Current research and future trends of molybdenite byproduct operations.

Robert E. Cuthbertson, resident director, western research operations, Climax Molybdenum Company was scheduled to speak on "New Facets in Flotation at Climax." He did, too, and they were much newer than those facets outlined in his prepared speech which he urged all to read in the special Colorado Mines Quarterly (see box). He then announced that there had been a recent break through in the recovery of non-sulphide molybdenum in Climax's mixed ores. "Now something can and will be done to recover it," he said. This non-sulphide is found in a small amount in the ore body's cap rock or near the surface material. Total of this material is large. Just under the capping is mixed ore, about 50 percent each of sulphide and non-sulphide. Some of this is now in mill feed. Another oxide source is the tailing ponds.

Laboratory studies indicate that the non-sulphide can be floated for upgrading to produce a concentrate for final hydrometallurgical treatment. He said, that it might be possible to mine selectively from oxidized areas, crush separately, grind, and float in one seventh of the circuit to recover a special concentrate.

Iron—The Late Comer

Flotation of iron has had the "long wait" reported Louis Ereck, chief metallurgist, the Cleveland-Cliffs Iron Company. This wait has been due to plentiful deposits of high-grade ores and to competition.

High-grade ore grows scarcer every year. As to competition he said, "Spirals on one side and the potential of magnetic oxide conversion on the other is realistic, but fortunately there is room in the middle for flotation." Fortunately MINING WORLD readers have the opportunity to read about the newest flotation plant for iron ore—Humboldt Mining Company's Michigan mill—in this issue.

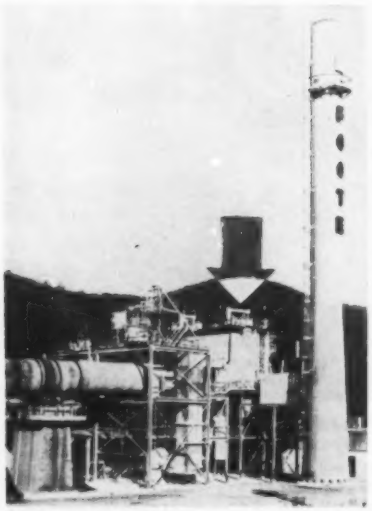
"Still some beginning," both a challenge and an opportunity lies ahead in flotation. The world's metallurgists assembled in Denver accept the beginning premise. END

50th Anniversary Volume For Sale

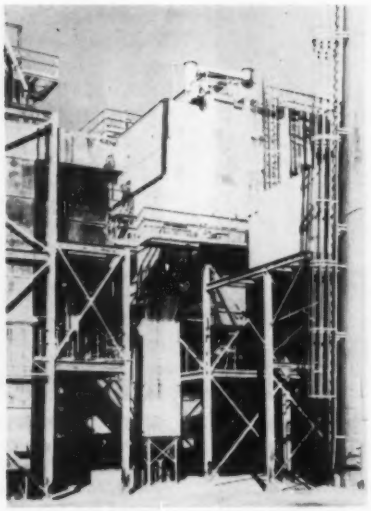
The Colorado School of Mines at Golden, Colorado has published a special two-volume edition of its Quarterly titled: "Fiftieth Anniversary of Froth Flotation in the U. S. A." which contains the speeches and papers delivered at the Golden Jubilee celebration.

This special volume was edited by professor Hildreth Frost of the Metallurgical Department. It contanis 600 pages, 37 articles, numerous charts, diagrams, and illustrations.

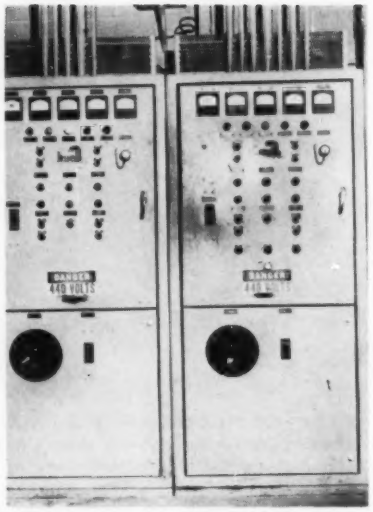
This price for these volumes is only $5.00. Please write directly to professor Frost with a payment of $5.00 enclosed for the full report of the celebration for your metallurgical library.



ROTARY KILNS, Buell electrostatic precipitator (arrow), and exhaust stack. Clinker dust is returned to process after separation from kiln exhaust gas. Dust recovery is 97.5 percent efficient—54 tons per day.



BUELL PRECIPITATOR with vertical inlet duct. Horizontal baffle pipes have been installed in duct to improve gas distribution and increase efficiency. Frame on which baffles are mounted extends downward at about 20° angle.



PRECIPITATOR CONTROL panels incorporate main power supply switch, voltage regulator, transformer start-stop buttons, rectifier-tube filament, rapper motors, high-voltage terminal heaters, and five voltage and ampere meters.

How Foote Mineral Cuts Stack Loss With Electrostatic Precipitators

Foote Mineral Company is recovering up to $125,000 worth of lithium aluminate annually that formerly was lost up the stack in the form of fine dust at its Sunbright, Virginia plant. Shortly after the plant started operation two Buell Engineering Company electrostatic precipitators were installed to treat kiln exhaust gas. Average precipitator efficiency is 97.5 percent to recover and recycle 54 tons of lithium aluminate daily which was initially lost to the atmosphere. The lithium aluminate is an intermediate product in Foote's thermo-chemical process for producing lithium hydroxide from spodumene ore mined at its North Carolina mine.

Each of the two outdoor precipitators treats exhaust gas from one of two 10- by 340-foot rotary kilns. Exhaust gases first pass through dust chambers and cyclones before entering the precipitators. Suitable ducting permits diversion of all gases through either precipitator to permit continued kiln operations during maintenance on one unit. The precipitators are located side by side and insulated as one unit, a common wall separating the two. This eliminates one wall and the insulation of two walls, as would be required with two completely separate units.

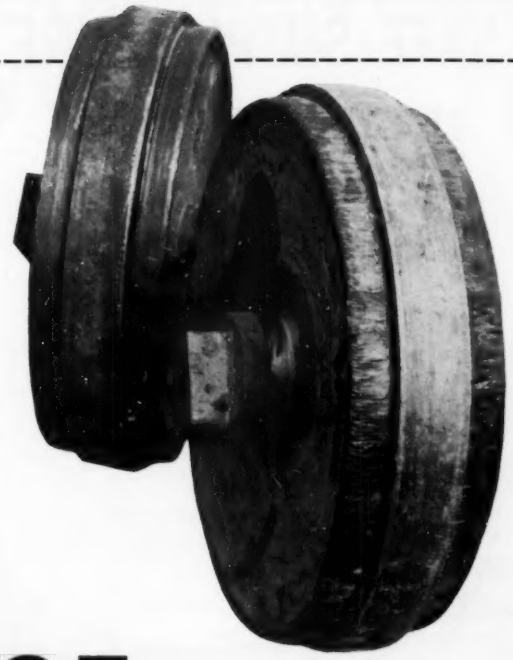
Each precipitator has four hoppers in series to collect dust removed from the exhaust stream, and recycled by screw conveyors. Hoppers are equipped with vibrators and are insulated to prevent moisture from condensing and wetting the reclaimed dust. Gas temperature ranges from 475 to 520° F. Gas volume is about 73,500 cubic feet per minute per kiln.

The Foote Mineral collector is equipped with an audible alarm which sounds off should either of the three conveyors become inoperative, or should a short occur in the precipitator. If a short has occurred, the precipitator automatically shuts off. A short could be caused by a build up of dust between the emitting-electrode wires and collecting-electrode plates, or conceivably by a slack or broken emitting electrode contacting a collecting plate. The precipitator automatically restarts itself in event of a short, and only if on the third try, or "recycle," does the alarm sound if the shut-down persists. When the alarm sounds, a pilot light indicates whether the trouble is with a conveyor or due to a short. The alarm must be turned off before restarting.

Precipitator transformer-rectifiers were designed to step up 440-volt AC supply voltage to as high as 66 kilovolts and then convert it to DC. Normal operating voltage, however, is 45 kilovolts. The transformer rectifiers, one for each precipitator unit, are located on the roofs of the precipitators. This location is close to the emitting-frame terminals and is in a safe, out-of-the-way area. Both the transformer and rectifier are immersed in oil, the rectifier being of the electronic-tube type.

The rectifier cover cannot be removed while the main power supply is connected. A key interlock system necessitates release of the cover with a key, and this key can only be removed from its keyblock by means of a master key normally in its lock on the control panel. When the master key is removed from its lock, the main power supply is off. Power can't be resumed until the master key is returned to the control panel, and this necessitates replacement of the rectifier cover and return of the cover key to its keylock. END

popular Stoody 105 available as Manual Electrode...



STOODY 1105



For the company maintenance shop desiring to rebuild its own heavy machinery undercarriage parts, but not having sufficient rolling stock to warrant the installation of automatic welding equipment... *here is the ideal electrode.* Providing the same deposit properties as the widely used Stoody 105 automatic hard surfacing wire, Stoody 1105 may be used for hard-facing tractor rollers and idlers, arch wheels, shovel rollers and idlers, charging car wheels and sprockets, as well as churn drills and other equipment subject to severe impact and abrasion and metal-to-metal wear.

Literature describing STOODY 1105 is available. See your nearest STOODY DISTRIBUTOR (check the "Yellow Pages" in your phone book) or write direct.

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ORANGE WAX SEQUOIA . . . for maximum visibility
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STATEMENT OF OWNERSHIP

Statement required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933, and July 2, 1946 and June 11, 1960 (74 Stat. 208) showing the ownership, management, and circulation of Mining World, published monthly except in April when publication is semi-monthly at Lancaster, Pennsylvania, for October 1, 1961.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publishers: Wm. B. Freeman, Miller Freeman, Jr., 500 Howard Street, San Francisco 5, California; Editor: George O. Argall, Jr., 500 Howard Street, San Francisco 5, California; Managing Editor, none; General Manager, H. G. Grundstedt, 500 Howard Street, San Francisco 5, California.

2. The owner is: Miller Freeman Publications, Incorporated, 500 Howard Street, San Francisco 5, California; Wm. B. Freeman, 500 Howard Street, San Francisco 5, California; Miller Freeman, Jr., 500 Howard Street, San Francisco 5, California.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: NONE.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner. 5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: 10,606. Miller Freeman, Jr., Publisher. Sworn to and subscribed before me this 1st day of October, 1961. (Seal) Barbara M. Hampson, Notary of the Public, San Francisco, California. (My commission expires February 18, 1962.)

Metal & Mineral Prices

U. S. A.

October 17, 1961

METALS

COPPER: Electrolytic. Delivered F.o.b. cars, Valley basis (pound)	31.00¢
Lake. Delivered, destinations, USA	31.00¢
Foreign. Delivered, destinations, USA	31.00¢
LEAD: Common Grade. New York (Per pound)	11.00¢
Tri-State Concentrate, 80% lead, per ton	$125.16
ZINC: Prime Western: F.o.b. E. St. Louis (Per pound)	11.50¢
Prime Western: Delivered New York	12.00¢
Tri-State Concentrate, 60% zinc per ton	$68.00
ALUMINUM: Primary 50 Pound Ingots (99.5% plus) (Per pound)	24.00¢
ANTIMONY: Lone Star Brand. F.o.b. Laredo, in bulk (Per pound)	33.00¢
BISMUTH: (In ton lots) price per pound	$2.25
CADMIUM: Sticks and bars. 1 to 5 ton lots Price per pound	$1.60
COBALT: 97-99%, keg of 500 pounds (Price per pound)	$1.50
COLUMBIUM: Ingot Nominal, per pound	$36.00-$55.00
GERMANIUM: dioxide, high purity, gram	16.75-21.75¢
LITHIUM: 98% (per pound)	$9.00-$12.00
MAGNESIUM: Ingots (99.8%) F.o.b. Velasco, Texas per pound	36.00¢
MERCURY: Flasks. Small lots, New York	$188.00-$191.00
NICKEL: "F" Ingots (5 pounds) F.o.b. Port Colbourne, Ontario	82.75¢
PLUTONIUM: To July 1, 1962 AEC will pay $30.00 to $40.00 per gram depending on plutonium 240 content. July 1, 1962 to June 30, 1963, per gram	$30.00
SELENIUM: 99.5% per pound	$6.50-$7.00
TELLURIUM: Common grade, Per pound	$5.25
THORIUM: per kilogram	$43.00
TIN: Grade A Brands. New York (Per Pound) Prompt delivery	120.875¢
TITANIUM: 99.3% + Grade A-1 Sponge (Per pound)	$1.37-$1.60
URANIUM: Normal, Per Pound	$24.00
VANADIUM: 98% Grade	$3.45
GOLD: United States Treasury Price	$35.00 per ounce
London	$35.16 per ounce
SILVER: Newly mined domestic. U.S. Treasury price per ounce	90.5¢
Foreign Handy Harmon	91¾¢
PLATINUM: Per ounce	$82.00-$85.00
ZIRCONIUM: Sponge, Per pound, Reactor Grade	$5.00

ORES AND CONCENTRATES

BERYLLIUM ORE: 10 to 12% BeO. F.o.b. mine, Colorado	$46.00 per unit
Small lot purchases at Custer, S. D., Spruce Pine, N. C., and Franklin, N. H. Visual inspection at $400.00 per short ton or by assaying at 8.0 to 8.9% BeO, $40 per unit; 9.0 to 9.9%, $45; over 10.0%, $48.00.	
CHROME ORE: F.o.b. railroad cars eastern seaports. Dry long tons.	
African (Rhodesian). 48% Cr_2O_3. 3 to 1 ratio	$35.00-$36.00
African (Transvaal). 48% Cr_2O_3. No ratio	$26.00-$28.00
Turkish, 48% Cr^2O^3. 3 to 1 chrome-iron ratio Nominal	$36.00-$37.00
COLUMBIUM-TANTALUM ORE: Per Pound Pentoxide, Nominal	$1.10
IRON ORE: Lake Superior. Per gross ton Lower Lake Ports	
Mesabi, Non Bessemer, 51.5% Fe	$11.45
Coarse: Plus—½-inch	$12.25
Fines: Minus—½-inch	$11.00
Mesabi, Bessemer, 51.5% Fe	$11.60
Old Range Non Bessemer	$11.70
Old Range Bessemer	$11.85
Swedish, Atlantic Ports, 60 to 68% Fe Contracts, Per Unit	24.00-25.00¢
Brazilian, Atlantic Port, 68 to 90%, Long ton unit	22.00-22.50¢
Venezuelan, Orinoco No. 1, 58% Fe, f.o.b. Puerto Ordaz	$8.95
MANGANESE ORE: Metallurgical grade. 48 to 50% Mn Long ton unit	$0.90-$0.95
Metallurgical grade. 46 to 48% Mn. Long ton unit	$0.85-$0.90
Metallurgical grade. 44 to 45% Mn. Long ton unit	$0.85-$0.90
Domestic U.S. Government. GSA Basis $2.30 per unit for 48% Mn.	
MOLYBDENITE CONCENTRATE: 90% MoS_2 F.o.b. Climax, Colorado. Per pound Mo, plus container cost	$1.40
TUNGSTEN CONCENTRATE: Domestic. 60% WO_3 Per short ton unit Nominal	$23.50
Foreign: 65% WO_3 Per short ton unit (Scheelite) Nominal	$17.00
Foreign: South American, Spanish, Portuguese Nominal	$16.50
URANIUM ORE. F.o.b. purchase depot or company mill in accordance with AEC schedules and company buying contracts. Basic price is $1.50 per pound of U_3O_8 in ore assaying 0.10 percent. For each additional 0.01 add 20¢. Subject to development allowance, premiums, penalties where applicable.	

NON-METALLIC MINERALS

BARITE: Oil well drilling. Minimum 4.25 specific gravity, per short ton	$16.00
BENTONITE: Minus-200mesh. F.o.b. Wyoming. Per ton, carload lots	$12.50
Oil Well grade. Packed in 100 pound paper bags	$14.00
BORON: technical grade F.o.b. Boron California. Per ton	$47.50
FLUORSPAR: Metallurgical grade. 72.5% effective CaF_2 content per short ton F.o.b. Illinois-Kentucky mines	$37.00-$41.00
Mexican. 70% F.o.b. border, Duty paid	$27.00-$28.00
Acid Grade. 97% CaF_2 Bulk, F.o.b. mine	$45.00-$49.00
PERLITE: Crude: F.o.b. mine per short ton	$3.00 to $5.00
Plaster grades. Crushed and sized. F.o.b. plants	$7.00 to $9.00
SULPHUR: Long ton, f.o.b. cars, mines	$22.50-$23.50
F.o.b. vessels Gulf Ports	$24.00-$25.00

London

October 17, 1961

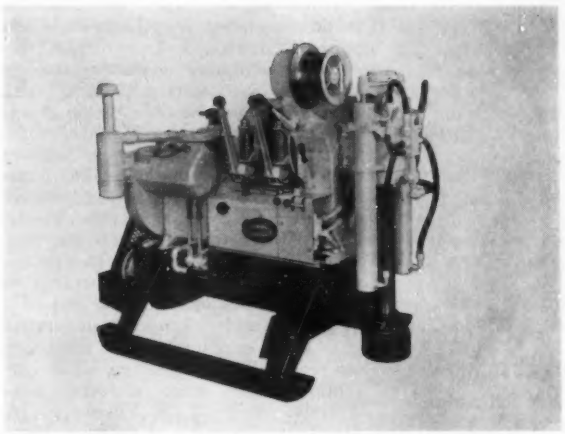
		Per Long Ton	USA Equivalent	cents per pound
COPPER:	Electrolytic, spot	£231	5s 0d	28.91¢
LEAD:	Refined 99%	£ 62	17s 6d	7.86¢
ZINC:	Virgin 98%	£ 71	17s 6d	8.98¢
ALUMINUM:	Ingot, 99.5%	£186	0s 0d	23.25¢
ANTIMONY:	Regulus, 99.6%	£230	0s 0d	28.75¢
TIN:	Standard, 99.75%	£938	0s 0d	117.25¢
TUNGSTEN:	Long ton unit	£ 0	130s 0d	$18.26

*With Sterling Pound at $ 2.80

Quotations on metals and certain ores through the courtesy of *American Metal Market, New York, New York*

PRODUCTION EQUIPMENT preview

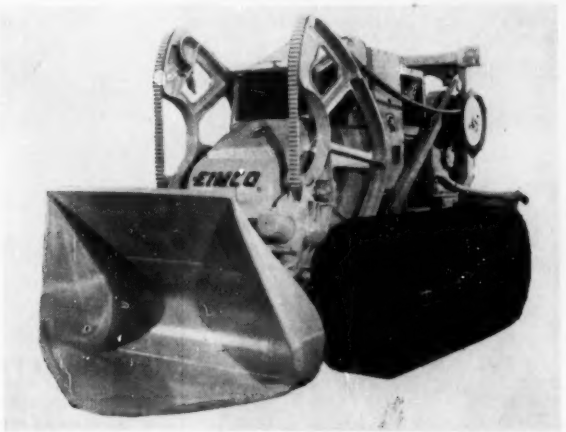
FOR DATA ON ANY ITEM IN THIS SECTION PLEASE WRITE MANUFACTURER DIRECT



New Core Drill Has Many Exclusive Features

A new diamond drill—the Longyear 38—incorporates many exclusive features which drillers need to take advantage of modern drilling techniques.

The "38" features an eight-speed transmission with spindle speeds from 69 to 1,850 revolutions per minute running at 2,200 revolutions per minute. Special low-range speeds permit efficient casing rotation, rock bitting, soil sampling, and other applications. All controls are grouped at the operator's fingertips. Gasoline, Diesel, air or electric power units are optional. Convenient chassis breakdown makes the unit easy to transport with helicopter or pack train. Write: **E. J. Longyear Dept. MW, 76 South Eighth Street, Minneapols, Minn.**



Electric Excavator Overcomes Exhaust Problems

The Eimco Corporation's Tractor/Loader division has announced the addition of a new electric-powered excavator that overcomes Diesel exhaust problems.

The Eimco 105E excavator is powered by a 100 horsepower 50 or 60 cycle electric motor of from 220 through 550 volts. Standard bucket capacity is one cubic yard, and the massive standard machine weighs 38,500 pounds. Speeds range up to 4.2 miles per hour in either forward or reverse. Maximum drawbar pull with zero track slippage at sea level is 40,000 pounds. Discharge heights of from 9-foot six-inches to 12-foot five-inches are available. Write: **A. F. Mansbach, The Eimco Corporation, Dept. MW, P. O. Box 300, Salt Lake City, Utah.**

Independent Hydraulically Rotated Roof Pinner Introduced By Gardner-Denver

After extensive field testing, a new type of roof pinner is currently being introduced to the mining industry by the Gardner-Denver Company. The D73HRR performs all phases of the roof pinning operation. This new tool is designed to drill the hole, insert the roof bolt and tighten the bolt to the required torque. This new hydraulic/pneumatic roof pinner drill incorporates an independent hydraulic rotation motor. It also has its own pneumatic feed motor to feed the drill steel into the hole while drilling, plus a pneumatic centralizer for maintaining proper steel alignment.

This new drill features remote control, adjustable feed mounting, and a hydraulic motor of sufficient power for tightening roof bolts to safe torque levels accurately and consistently. It is one of the few roof pinners designed to do the complete roof bolting job—drilling the hole, pulling the steel, and inserting and tightening the bolts. A special mounting plate provides adequate clearance for roof bolt assembly.

Additional information is given in Bulletin 6–6KK just released by the company. For a free copy write: **C. L. Ruyle, Gardner-Denver Company, Dept. MW, Quincy, Illinois.**



Rock Drill Simultaneously Combines Rotary Milling With Percussion Hammering

A new rock drill has been introduced that combines the best features of rotary and percussion drilling. Known as the Rotary Percussion Drill, or the Joy RPD, it is designed to penetrate most rock formations two to three times faster than any other drill. It is best suited for tunneling and underground mining operations with holes 1¼ to 1¾ inches in diameter up to 16 feet deep. Larger and deeper holes may be drilled in some formations. For information write: **Dave Green, Joy Manufacturing Company, Dept. MW, Oliver Building, Pittsburgh 22, Pennsylvania.**

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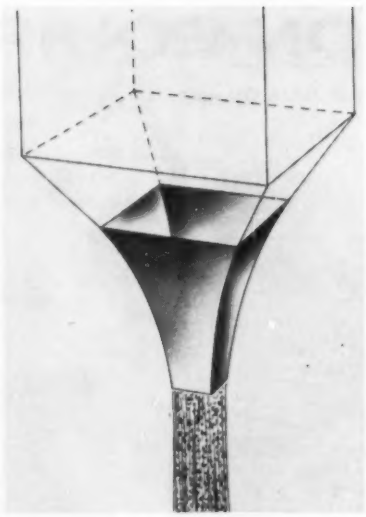
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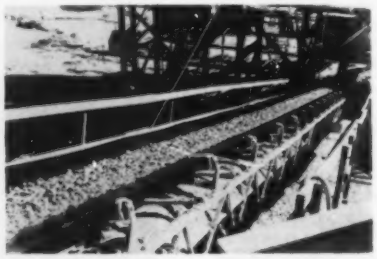
Bin Outlet Provides Fast Flow

A new device to provide full and uniform flow of granular and lump bulk materials from bins, hoppers, and silos has been developed by The Bin-Dicator Company.

The hyperbolic outlet eliminates bridging, rat-holing, and erratic flow of shale, stone, ore, and feed materials that tend to pack and bridge in conventional outlets. Write: **The Bin-Dicator Company, Dept. MW, 13946 Kercheval Avenue, Detroit 15, Michigan.**

Law Turbo Mill Made in Phoenix

The Law Turbo Pulverizer, described in the September issue of MINING WORLD, is no longer being made in El Paso, Texas. It is now manufactured by American Mining & Manufacturing Corporation, Phoenix, Arizona. For information write: **Marx Law, Dept. MW, P. O. Box 1382, Phoenix, Arizona.**



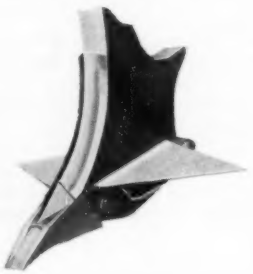
Unique Ribbed Conveyor Belt

A practical ribbed conveyor belt has been designed by Raybestos-Manhattan, Inc. to handle wet, slippery or soupy materials such as mixture of gravel and water up inclines. The chevron shapes ribs or cleats prevent the wet material or water from running back even when on an incline since the cleats form pockets that trap the water and hold the material. The belt can be reversed so that water will drain out of the mixture if desired. Write: **Raybestos-Manhattan, Inc., Dept. MW, Manhattan Rubber Division, Passaic, New Jersey.**

Aluminum Mine Cars Are Here

Aluminum mine cars, a rarity less than a year ago, have ascended from experimental to production status. Irwin-Sensenich Corporation, Irwin, Pennsylvania, announced it has started production of 125 units to be constructed of aluminum plate and extrusions supplied by Aluminum Company of America.

Due to equipment variations, the first shipment of 85 cars will feature cast aluminum bumpers, while the remaining 40 units will have automatic couplers. Orders for the new equipment followed successful trial runs of aluminum cars after Irwin-Sensenich and Alcoa cooperated in introducing an experimental lot of 20 light metal carriers last year. The experimental aluminum cars proved an economical advantage because of their light weight, and also passed a rigorous — and impromptu — strength test. In a derailment, one aluminum car received minor damage, while conventional cars were wrecked more severely. Write: **J. S. Ellenburg, Jr., Aluminum Company of America, Dept. MW, 1501 Alcoa Building, Pittsburgh 19, Pennsylvania.**



Alloy Steel Ripper Points

Job-rated ripper points made of heat treated forged alloy steel rather than cast carbon steel are available from Berkeley Forge & Tool. These high production points are made in four sizes and shapes (short, medium, long, and extra long), and offer durability and performance under all ripping conditions. Write: **Berkeley Forge & Tool, Dept. MW, 1330 Second Street, Berkeley 10, California.**

New Blaster Aids Measurement

A new, compact blasting device is helpful in mining and geophysical exploration to determine depths to bedrock. Bedrock determinations up to 100 feet, or more, can be made with the DynaMetric Model 117 Self-Powered Seismic Timer which uses an instrumented sledge hammer to generate the shock waves. The companion blaster, with seismic blasting caps, greatly extends the range of the seismic instrument for use in deep mineral exploration and overburden studies. For information write: **DynaMetric, Inc., Dept. MW, 2955 E. Colorado Blvd., Pasadena, California.**

Versatile "Desert Rat" Traverses Rough Country With Special Low Pressure Tires



A vehicle designed to provide transportation beyond the "end of the road" for geologists, prospectors, and others who blaze their own trails was introduced recently.

Remote Area Transportation Corporation said the four-wheeled "Desert Rat" will allow outdoorsmen to extend their searchers to the least accessible places, traversing steep hills, swamp, sand and large rocks. It has molded plastic seats for two, and carrying space for equipment and supplies. Mobility is possible by the use of Terra-Tires designed by The Goodyear Tire & Rubber Company. Their size, high sidewall deflection and air inflation requirement of only two to five pounds per square inch, keep them from bogging down in sand or mud.

A one-cylinder gasoline engine powers the vehicle to speeds of 20 miles an hour. It has automatic transmission, and its steering wheel is located so that either rider may control it. For information write: **Howard Babcock, The Goodyear Tire & Rubber Company, Dept. MW, Akron 16, Ohio.**

"ENGINEERING in Action at Allis-Chalmers" is the story of developments in the Industries Divisions at Allis-Chalmers in 1960. Advances in all phases of company activities are recounted in the graphically illustrated 36-page magazine. Included are those steps taken in the continuing search for improved operations, increased efficiency, better products, and reduced costs. For your free copy write: **Tom Doyle, Allis-Chalmers Manufacturing Company, P. O. Box 512, Dept. MW, Milwaukee, Wisconsin.**

PORTABLE BUILDINGS: The introduction of a new line of portable aluminum field housing was announced recently by Porta-Kamp Manufacturing Company. These low-cost, practical field housing units are skid mounted, and may be shipped erected or knocked down to 1/5 their erected cube. The wide ranges of sizes available makes them ideal for any field housing need to fit customer requirements. For additional information write: **F. E. Bigelow, Jr., Porta-Kamp Manufacturing Company, Inc., Dept. MW, Houston 8, Texas.**

CRUSHING and screening equipment is outlined in Bulletin CC-1-61 recently released by Universal Engineering Corporation. The complete line of Universal Systemized Portable plants is graphically illustrated, and the 24-page bulletin tells how these units when balanced into a systemized plant will provide higher production and more profit. Write: **Don Conway, Universal Engineering Corporation, Dept. MW, 625 "C" Avenue NW, Cedar Rapids, Iowa.**

MAGNETIC DRIVES: Louis Allis Company has recently released Bulletin No. 3650 on magnetic adjustable speed drives available in ratings from 50 through 2,500 horsepower. They can be applied to many varied applications, and the bulletin describes in detail the basic components of the magnetic drive, theory of operation, controls and design features. Write: **C. Czapinski, The Louis Allis Company, Dept. MW, 427 E. Stewart Street, Milwaukee 1, Wisconsin.**

SELF–CLEANING magnetic separator that is available in three types for suspending over conveyors, chutes, or spouts is described in Bulletin 1206B-N. The literature tells how the Dings Self-Cleaning Perma-Plate separates tramp iron from the burden by magnetic attraction—without manual attention for cleaning. Write: **Dings Magnetic Separator Company, Dept. MW, 4740 W. Electric Avenue, Milwaukee 46, Wisconsin.**

FIRST AID: Specially designed for training work, a 58-piece first aid outfit is described and illustrated in literature now available from Mine Safety Appliances Company. The outfit contains all equipment recommended by the U. S. Bureau of Mines for first aid training and emergency use, and is packaged in a 14- by 13-inch steel case. For a copy of Bulletin No. 0408-23 write: **Mine Safety Appliances Company, Dept. MW, 201 No. Braddock Avenue, Pittsburgh 8, Pennsylvania.**

THICKENERS are covered in a new 24-page brochure, Bulletin No. 3002, which describes the complete line of Dorr-Oliver thickeners for chemical, metallurgical and industrial processing. The new brochure describes and lists standard sizes and specifications for single and multiple compartment thickeners having both center-drive and perimeter-drive rakes in a variety of configurations for unit operations in all the process industries. For a free copy write: **Howard Mehr, Dorr-Oliver, Inc., Dept. MW, Stamford, Connecticut.**

HEAT EXCHANGER designed for high-volume cooling or heating of bulk materials, is described in a six-page Folder No. 2911 released by Link-Belt Company. Diagrams and photographs illustrate the simple, compact design of the Roto-Fin, which is a rotating drum with a series of flat, dual-purpose hollow fins or "cells" lapped consecutively around the inside of the drum to form an Archimedes spiral. Write: **Link-Belt Company, Dept. MW, Prudential Plaza, Chicago 1, Illinois.**

ENGINEERING SUMMARY written by Loraine Gold Mines, Ltd., of a record-making shift development in Africa is available which contains detailed drawings, full descriptions of headings; water control, working procedures; ventilation, maintenance and performance achievements. For a free copy of this 18-page report write: **A. F. Mansbach, The Eimco Corporation, Dept. MW, P. O. Box 300, Salt Lake City 4, Utah.**

WRENCH AND TOOL catalog is available from Snap-on Tools Corporation. This well illustrated, 128-page book describes in detail complete lines of wrenches and hand tools for production assembly, maintenance work, and product service, ranging in scope from very small tools to the largest wrenches. Write: **G. A. Smith, Snap-on Tools Corporation, Dept. MW, 8123 28th Avenue, Kenosha, Wisconsin.**

CUTTING EDGE and end bit catalog covering ESCO cutting edges, end bits, and router bits is now available from ESCO Corporation. Reference tables are included that cover all major makes of graders, dozers, and scrapers, plus the ESCO cutting hardware that is available for them. Write: **ESCO Corporation, Dept. MW, 2141 N.W. 25th Avenue, Portland 10, Oregon.**

CORE BARRELS: Undisturbed samples from difficult formations are possible with Acker-Denison core barrels. With this advanced design core barrel, top quality cores can be obtained from rare earths, ceramic clays, and other soft formations. For detailed information write for a free copy of Bulletin 1100MW: **Acker Drill Company, Inc., P. O. Box 830, Scranton 2, Pennsylvania.**

VIBRATING FEEDER: A bulletin now available describes the Hewitt-Robins heavy-duty Eliptex feeder, an entirely new mechanical vibrating unit, and the industry's largest. Feeder consists of two parts—a vibrator and a one-piece pan weldment with or without grizzly section. For a free copy of Bulletin 169A write: **Dept. VF (MW), Hewitt Robins, Stamford, Connecticut.**

COPPER CONTENT of water down to values of 5 ppb. can now be continuously determined automatically by a new method detailed in a new two-page data sheet. Write: **Technicon Controls, Inc., Dept. MW, Chauncey, New York.**

VACSEAL PUMP catalog has just been issued that is full of engineering data and specifications on all sizes of solids-handling and acid pumps. Write: **The Galigher Company, Dept. MW, P. O. Box 209, Salt Lake City 10, Utah.**

CRAWLER SHOVEL PAD: A new four-page folder covering the Columbia Steel Casting Northwest Model Six Crawler Shovel Pad is available giving comprehensive information concerning this Armor-Tough, Manganese Steel Columbia replacement part, including metallurgical data, dimensions, weight, drawing numbers, etc. For a free copy of Bulletin No. 1074 write: **Columbia Steel Casting Company, Inc., Dept. MW, 933 N. W. Johnson, Portland 9, Oregon.**

DOZER END BITS are the subject of an eight-page brochure by American Manganese Steel Division of American Brake Shoe Company which gives all relevant part numbers and complete catalog information on end bits for various tractor models and dozer types. Write: **American Manganese Steel Division, Dept. MW, 389 East 14th Street, Chicago Heights, Illinois.**



Replaceable Rock Bit Cones

A totally new concept in rock bit design has been developed by Varel Manufacturing Company which allows individual cones on rock bits to be changed as needed. According to the company savings realized from this unique development will at times be as much as two-thirds the price of a new bit. For literature, information and prices write: **B. R. Porter, Varel Manufacturing Company, Dept. MW, 9230 Denton Drive, Dallas 20, Texas.**

REAGENT FEEDING SYSTEMS: Industrial Physics and Electronics Company has just modified and reorganized its Time Modulated Reagent Feeding Systems, and has issued data sheets which describe the equipment that provide automatic feed rate control of the addition of liquid chemicals or reagents to flotation circuits. Write: **C. M. Marquardt, Industrial Physics and Electronics Company, Dept. MW, 470 South Tenth East Street, Salt Lake City 2, Utah.**

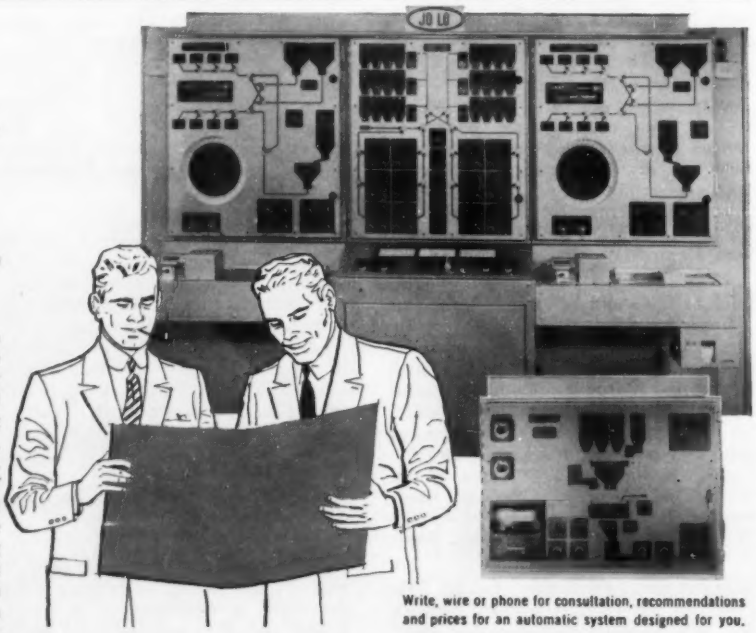
HIGH CAPACITY CRUSHERS for the lower cost production of uniformly crushed rock, ores, minerals and gravel are offered in four different types in a wide range of sizes and capacities by Gruendler Crusher & Pulverizer Company. Write: **Dept. MW-661, 2915 N. Market Street, St. Louis 6, Missouri.**

BUCKET ELEVATORS for fast, efficient, low-cost handling of all free-flowing bulk materials are described in a new comprehensive bulletin. Write: **C. E. Parkin, Barber Greene Company, Dept. MW, Aurora, Illinois.**

GOOD BELT CONVEYOR practice for mining is the subject of a booklet that describes some of the more common belt conveyor maintenance problems, their causes, and methods for correcting them. Write: **Hewitt-Robins, Dept. MW (OM), Stamford, Connecticut.**

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J. C. KINNEAR

George E. Kruger, vice president and technical director, mining industry, of the Chase Manhattan Bank, New York, New York, has been elected a director of Inspiration Consolidated Copper Company.

Lester S. Heyborne has been appointed superintendent of mining for the new Atlantic City, Wyoming, taconite mine, now under development by Columbia-Geneva Division, United States Steel Corporation. Heyborne became associated with U. S. Steel in 1947 at Columbia Iron Mining Company's open pit operations in Iron County, Utah. He has served as supervisor of mining engineering for Columbia Iron Mining since 1955.

Dr. Charles I. Whitman, specialist in chemical and metallurgical research, has joined the Copper Products Development Association, New York, New York as assistant technical director. In his new position, Dr. Whitman is responsible for liaison between the association and other research organizations in the United States under contract with CPDA.

Lauren K. Hanson has succeeded the late **William J. Michels** as Hibbing, Minnesota district chief mining engineer of the Cleveland-Cliffs Iron Company.

Peter F. Mataich, operations research consultant in the corporate industrial engineering department of International Minerals and Chemicals Corporation, has been transferred to the agricultural chemicals division's Florida operations as senior operations research engineer.

Fred H. Bunge, supervisor of the Hanna Company's research laboratory in Hibbing, Minnesota, has been named assistant director of research. His headquarters will be at the company's executive offices in Cleveland, Ohio.

E. F. Young, supervisor of Jones and Laughlin Steel Corporation's Graham Laboratory at Pittsburgh, Pennsylvania, has been transferred to the firm's Michigan ore dressing laboratory at Negaunee as supervisor. He succeeds **H. T. Ameen**, who has resigned.

E. C. Skinner, operations manager and **Dave Stark**, vice president of International Minerals & Chemicals Corporation, Agricultural Chemicals Division, Carlsbad, New Mexico, recently toured German potash mines on a trip to Europe. **Mervyn Upham**, operations manager in Canada, accompanied them on the trip.

Richard W. Lottridge, consulting engineer with Lottridge-Thomas & Associates, Salt Lake City, Utah, was one of the panelist speakers at the Colorado Bar Association's Mineral Law Section fall meeting, held recently at the Broadmoor Hotel, Colorado Springs, Colorado. Panel discussion covered conflicts between oil and gas leases and mining claims.

Harold Lowe, formerly associated with American Cyanamid Company, has accepted a position as mill superintendent with Tri-State Zinc, Inc. He will be in charge of Tri-State's 2,800-ton-per-day zinc mill now under construction at New Market, Tennessee.

Garvin L. Augustadt has been named to succeed **Darrell Gardner** as general manager of Magma Copper Company's operations at Superior, Arizona. Mr. Gardner has retired after 36 years of service with the company. **Hubert J. Steele**, former assistant mine superintendent, will succeed Mr. Augustadt as general superintendent of Magma's Superior operations. **Walter W. Chafey**, former division foreman, will assume the position of general mine foreman.

Dr. James R. McNitt, staff geologist with the California State Division of Mines and Geology, San Francisco, California, has returned from Rome, Italy, where he participated in the United Nations Conference on New Sources of Energy. Dr. McNitt presented a paper entitled "Geology of the Geysers Thermal area, California."

Charles D. Borror, former production engineer for the asbestos fiber division of Canadian Johns-Manville Co., Ltd., has been appointed manager of Coalingua Asbestos Company in California.

Lee Ackerman has been elected president and a director of Western Gold & Uranium Inc. **David P. Shirra**, vice president and treasurer, was elected executive vice president. At the same time, the board of directors voted to transfer company headquarters from New York to Phoenix, Arizona. Ackerman was president of the Lee Ackerman Investment Co. (which has been acquired by Western Gold & Uranium).

Walter C. Dow, former smelter superintendent at the Chino Mines Division of Kennecott Copper Corporation, Hurley, New Mexico, has been named smelter plant operations scheduling foreman at the Garfield smelter of the Utah Copper Division.

Charles D. Michaelson has been appointed vice president, mining, of Kennecott Copper Corporation, with headquarters in New York, New York. Mr. Michaelson, who has been with Kennecott since 1948, had served as general manager of the company's Western Mines Division, with offices in Salt Lake City, Utah, since 1955. He will be succeeded in that capacity by **John C. Kinnear**, who joined Kennecott in 1938 and has served as general manager of the Nevada Mines Division, McGill, Nevada, for the past 11 years. **M. J. O'Shaughnessy**, assistant to Mr. Kinnear since 1955, has been promoted to general manager of the Nevada Mines Division.

Richard A. Cabell, vice president of The International Nickel Company, Inc., New York, New York, and **W. M. Kirkpatrick**, western general counsel of The Anaconda Company, Butte, Montana, have been appointed to the mineral and metal mining department of the United States Chamber of Commerce's Natural Resources Committee. Reappointed to the committee from the mining industry are **John Edgar**, Sunshine Mining Company; **Jay B. Ford**, U. S. Borax and Chemical Corporation; **Oscar A. Glaeser**, United States Smelting, Refining & Mining Co.; **Herbert C. Jackson**, Pickands-Mather & Company; **Paul B. Jessup**, Kennecott Copper Corporation; **R. A. Learnard**, Aluminum Company of America; **Claude O. Stephens**, Texas Gulf Sulphur Company, and **Felix E. Wormser**, consulting mining engineer.

Jack W. Buford has been advanced to the newly created post of manager of South American operations of the Hanna Mining Company. Mr. Buford will continue as assistant vice president of operations with headquarters in Cleveland, Ohio.

Al Boeglin, formerly employed by Union Carbide Nuclear Company in Rifle, Colorado, has joined the Carlsbad, New Mexico operations of International Minerals and Chemical Corporation as a chemical engineer.

C. E. Langbein has been promoted to project engineer for the Bartow, Florida operations of International Minerals and Chemical Corporation. He jointed IMC in January 1960 as a senior design draftsman.

F. D. MacKenzie, mining geologist of Tucson, Arizona, has been named chief geologist in charge of the newly created geological department of Banner Mining Company, with headquarters in Tucson.

WHAT'S GOING ON in mining

Canadian Potash Mining Challenges Homestake-U. S. Borax Engineers

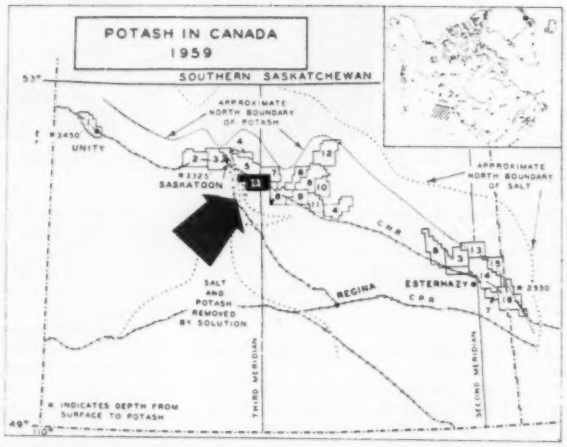
Homestake Mining Company, largest gold miner in the United States, has joined United States Borax & Chemical Corporation, largest boron producer, in a joint venture to determine economic feasability of bringing Borax's deep Canadian potash deposits into production.

U. S. Borax began diamond drilling in 1955 for potash southeast of Saskatoon on the large claim group shown in black on the accompanying map. In early 1959 17 deep holes had been completed and none have been reported since. However, results togther with data on the difficulties that the adjoining Potash Company of America, Ltd. is having in bringing its mine into commercial production give the two partners sufficient data on which to plan a new mine and flotation plant.

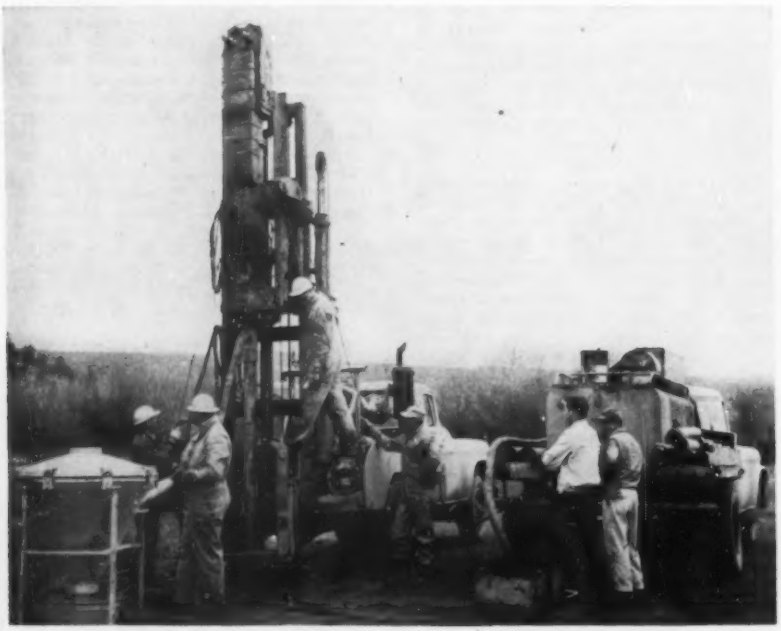
Notice from map how this is the deep end of the basin, but potash ore is high grade and beds are thick. However, sinking through the overlying 200-foot-thick Blairmore formation of fine sand and shales charged with very high volumes of water under great pressure has presented major problems to Potash Company, and International Minerals & Chemical Corporation (Canada) Limited to the east near Esterhazy. Potash Company froze through the Blairmore and then almost lost shaft where grouting has been going on for about a year. International first tried grouting and recently "tubbed" through the formation successfully.

Potash Company mined and shipped about 30,000 tons of ore in 1959 to confirm drilling widths and grades before water in the shaft and other problems forced suspension of mining.

Homestake's engineers, toughened by Ambrosia Lake's water problems, face a real challenge in Canada. International's "tubbing" looks good so the problems of bottom heave, plastic deformation, and pillar flow now occupy Homestake and Borax.



POTASH CLAIMS in 1959 as reported by Canadian Department of Mines and Technical Surveys. Ownerships: 1. Continental Potash. 2. National Potash. 3. Duval Sulphur and Potash. 4. Southwest Potash. 5. Potash Company of America. 6. U. S. Borax (in black). 7. Low and Morrow. 8. Alwinsal Potash. 9. Commonwealth Potash. 10. Sturgeon Petroleum. 11. General Petroleums. 12. Honolulu Oil. 13. Canadian Amco. 14. International Minerals. 15. Canberra Oil. 16. S. A. M. Explorations.



New Placer Drill Drives Double Casing For Sampling

A PLACER DRILL which uses a pile driver action to force a double steel casing down through sand and gravel was used successfully on ground of **Vermilion Gold, Inc.**, Sanders County, Montana. The machine averaged about one and a half feet of hole per minute and recovered one cubic foot of material in each 18 feet. The truck-mounted, Diesel-powered drill is the invention of Norman Becker, seismologist from Calgary, Canada. Equipment includes a water tank truck, an air pump for forcing water down through the outer casing and drill cuttings out through a rubber hose into a hopper, and a portable washing plant. Frank D. Duvall, Spokane, Washington, is one of the owners of the company.

Second Computer Symposium Meets in Tucson, March 26

The College of Mines of the University of Arizona, Tucson, has announced that a workshop and symposium on the use of electronic computers in the mineral industry will be held at the university campus March 26–30, 1962. This is the second annual meeting of this kind to be sponsored by the university. The first, held last April, was successfully attended by over 100 engineers and enthusiasts from six countires, and was reported in detail in the May 1961 issue of MINING WORLD.

For this coming meeting the College of Mines, University of Arizona, has joined with the School of Mineral Sciences, Stanford University, for the presentation of symposia, and according to present plans, the 1963 workshop and symposium will be held at Stanford University, Palo Alto, California.

The tentative program calls for a workshop to be held March 26 and 27 in cooperation with the Systems Engineering Department of the University of Arizona. The workshop subjects will include: Introduction to Computers, Programming and Mathematical Techniques, and General Computer Applications. The symposium will be held March 28 and 29, and will be divided into two categories: mining and exploration. Under mining the subjects will include: Mine Development, Mine Design, Production Scheduling, Equipment Analysis, and Quality Control. Under exploration the subjects will include: Regional Reconnaissance, District Investigation, and Deposit Evaluation.

Government Mining Administration in Republic of the Congo

. . . from Central African Special Correspondent



CONGO'S MINE OFFICIALS pictured at their central government headquarters in Leopoldville. On right is Emmanuel Mapwata, director of Mines and Power; in white is Pierre Luzola, assistant director.



DEMONSTRATING KATANGESE outside the United Nations headquarters in Elizabethville violently protest armed force by United Nation's troops against Katanga government. Many carry pangas, bush knives.

The "Service des Mines" headquarters staff, Leopoldville, is bigger in number than before the grant of Independence, but the output is small.

We can recall the illuminating annual reports of Mons. A. Vaes, director and his assistants G. Delville, Paul DuPont, and others, who covered mineral production throughout the country. In those days, headquarters occupied modest offices in the politically unfashionable Eastern outskirts of Leopoldville. Today the "Department of Mines and Energy" occupies the imposing, though ill-equipped apartments near the hub of government and the United Nations Building. No mining engineer remains in service.

The director today is Emmanuel Mapwata, who, with the assistant director, Pierre Luzola, is depicted in the MINING WORLD photo herewith, beside the official car. The establishment includes, in addition, secretary, assistant secretary, statistician, technical adviser, librarian, four stenographers and a few others. Very much a token force.

A dozen charts line office walls—all curves cut off abruptly at 1960. A fruitless administration is inevitable with the exclusion of Katanga's copper, cobalt, zinc, germanium, manganese, and tin from its sphere of responsibility. As for the diamond mines of Tshikapa and Bakwanga, flanking the unhappy town of Luluabourg, little can they feel concerned for the rendering of government returns, while the gold producers northeast of Stanleyville, and Symetain to the southeast, are even more remotely detached from Leopoldville interests.

On the whole, however, mineral producers have not fared too badly in these troubled times. Mining laid the foundations—technical, social and economic—upon which the nation stands and it is rightly held in full respect by all peoples. Battles are discreetly fought in places where stray bullets may be expected to fall clear of plants and works. Recent fighting in Jadotville was precariously near the "mines d'electrolyse" of Union Minière, but that was not the fault of Katangese.

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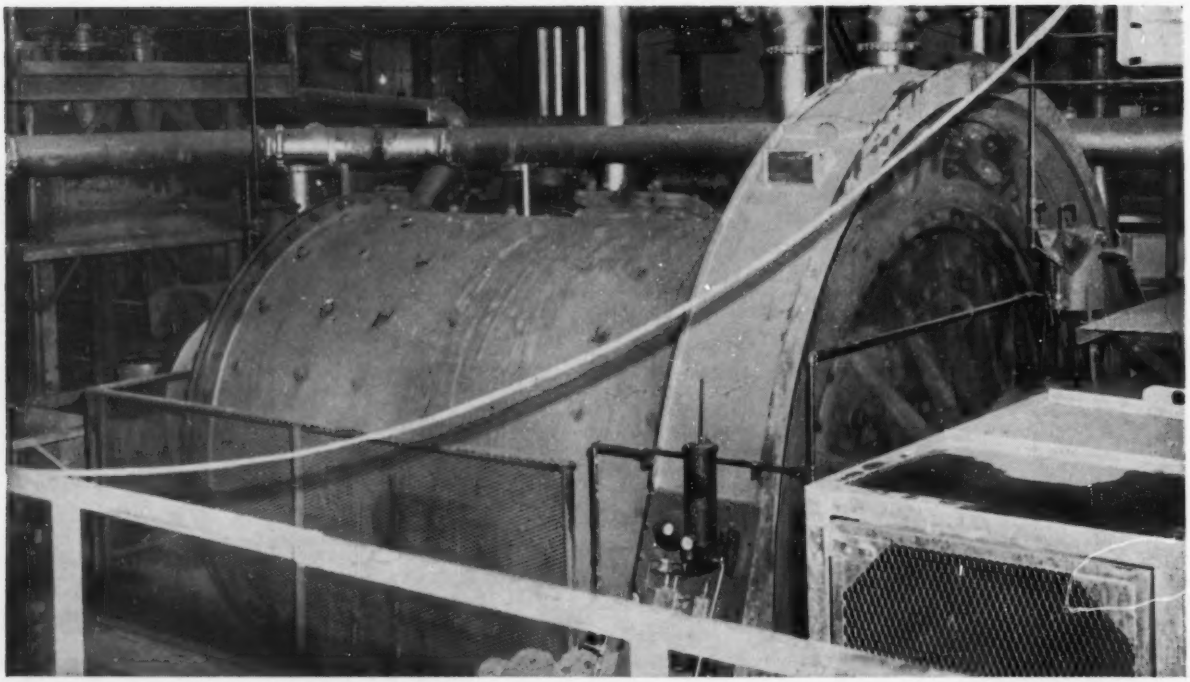
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Anaconda Selects Marcy Mills for its modernization program



One of three new 9′ x 14′ Marcy Ball Mills at Anaconda

Photo courtesy Mining World.

Anaconda Reduction Works, Anaconda, Montana, has an extensive modernization program to improve metallurgical results and reduce costs.

This program includes a regrind stage on rougher flotation concentrates and the company selected three 9′ x 14′ Marcy Ball Mills for the job.

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Alaska

Commissioner Phil R. Holdsworth, head of Alaska's **Department of Natural Resources,** recently returned from a 10-day official visit to Japan, and reports keen interest among Japanese industries for active participation in Alaska's resource development. To meet her changing and expanding raw material requirements, Japan is interested in timber, iron, copper, nickel, lead, zinc, and antimony, as well as petroleum products including liquified natural gas. However, the Japanese are generally unaware of the attractive features of Alaska's corporation, industrial tax incentive, and mining license tax laws, according to Holdsworth, who met with 14 leading industrial concerns, five government agencies, and several joint industry organizations.

Norman Schaefer, Wausau, Wisconsin, has started an exploration program on the **Russell Schaefer** cinnabar property. The work planned is limited to diamond drilling in an effort to determine whether the limited exposure has greater lateral and vertical extent than that in the open-cut exposed by the late Russell Schaefer, with future plans dependent upon drilling results. A total of seven men are employed on this project, which terminated in September. An appreciable amount of native quicksilver in the ore makes this an especially interesting occurrence. The property is on Cinnabar Creek, tributary to Upper Holitna River.

On the **Parks** mercury property, George Willis and John Murphy are operating a well-built two-tube Joshua Hendy-McKay retort, with two 12-hour cycles per 24 hours. Each tube is charged with an average of 150 pounds of selected high-grade, with recovery of 55 to 60 pounds of quicksilver from each 300-pound charge, or 110 to 120 pounds per 24 hours. The retort tubes were obtained from the Ozzie Willis prospect, and date back to 1917.

The diamond drilling program for cinnabar in the White Mountains by the **U. S. Bureau of Mines** has been slowed by frozen ground and the shattered ore zone.

Arizona

Production is continuing at the **Silver Crown** mine of the **Arizona-Michigan Mining Company** in the Walnut Grove district, near Prescott, Arizona. Workings consist of a 480-foot adit which intersects an old shaft, and two levels opened below the adit—at 130 feet and 190 feet. Shaft sinking is in progress at 70 feet below the No. 3 level and plans call for opening the No. 4 level at 300 feet below the adit level. Considerable stoping has been done between the No. 3 level and the adit in both directions from the shaft. Ore from this area currently is supplying the mill with an average of 15 tons per day. The mill is operating one shift daily; the mine two shifts with one on production and one on shaft sinking. In all 12 men are employed, 8 in the mine, 3 in the mill, and one tramming and trucking ore. Langley W. Rayner, Prescott, directs the work.

The **Bonanza Land and Mining Company,** Tucson, Arizona, Earl Brown, president, has started repair work and installation of mining equipment at the **Allison** mine in the Fresnal district of Pima County. The new operator, with five men employed, proposes to extend the **Fourth of July** shaft an additional 100 feet—to a depth of 400 feet— then crosscut to the Allison shaft—a distance of about 600 feet. Contract for the exploration and development work has been let to Frank Otero of Nogales. Bonanza purchased its lease on the Allison from Maurice Hedderman of Tucson. Hedderman had operated the property for some time and recently had been mining at the rate of from 500 to 700 tons monthly of gold-silver ore for shipment to the **Phelps Dodge Corporation's** smelter at Ajo, where it is used as high-silica flux. The Allison group of 20 unpatented claims is owned by the **Sawyer Petroleum Company** of Los Angeles, California.

International Molybdenum Mines, Ltd., through its wholly-owned subsidiary, **Ranwick, Inc.,** has sold its copper claims near Copper Basin to **Phelps Dodge Corporation.** The sale was $29,786 (Canadian) and a royalty of three cents a ton of ore mined. The Copper Basin area is west of Prescott, and has been the scene of active exploration recently.

A crew of eight men is employed at the former **Ambrosia** mill site near Aquila, Arizona, where old table tailings are being retreated. The heads are said to run from 5 to 8 percent manganese, and a concentrate averaging about 41 percent Mn is produced. Between 400 and 500 tons are handled daily by the bank of Humphrey Spirals in conjunction with alluviators (hydraulic sorting columns). The concentrates are shipped in about equal quantities to Henderson, Nevada, where they are converted to electrolytic manganese dioxide, and to Mexican Hat, Utah, for use in the uranium plants as an oxidant in the uranium circuits. The project is operated by **Thunderbird Metallurgical, Inc.,** which is headed by Conrad A. Stewart of Phoenix.

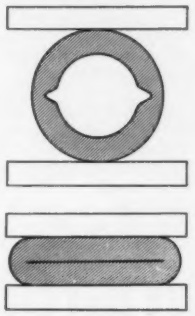
The **Catalina Mining Company** is continuing exploration work at the **Catalina** mines in the Canada del Oro district of Pinal County, Arizona. About one carload of ore a week is mined from exploration headings. In recent months the adit has been driven about 90 feet, following sinking of a 50-foot shaft which was abandoned temporarily because of water. Four men are employed under the direction of Loyd Harris, Tucson. Owners of the company are L. L. McGee, president, Tucson, and associates.

A new milestone in safety progress at **Ray Mines Division of Kennecott Copper Corporation** was reached August 24 when employees of the reduction plant worked a full year without a disabling injury. As far as is known, this is the first time in the long history of the property that either of the major plants at Ray or Hayden has worked a full year without a lost time accident. Since August 24, 1960, the date of the last disabling injury, the reduction plant employees have worked a total of approximately 1,452,167 man-hours accident free, and the record is continuing.

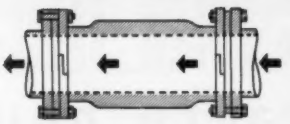
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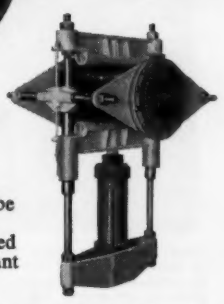
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Production of lead and zinc ore from the **Flux** mine continues with 47 men employed, 38 of whom work in the mine, 7 in the **Trench** mill, and 2 in the shops. Monthly output runs about 2,800 tons. In addition, a small tonnage, averaging about 20 tons monthly, is purchased from the **Indiana** mine, operated by **Alvaro Alvarez** and **Armando Majalca. E. W. McFarland**, Nogales, Arizona, in association with **James P. Nash** of Austin, Texas, is in charge of the Flux-Trench operations.

The **Arizona Department of Mineral Resources** has issued statistical reports of the lead and zinc, silver and gold, and copper industries in 1960, comparing salient statistics with those of other years. A copy of any of these reports may be obtained by writing to the Arizona Department of Mineral Resources, Fairgrounds, Phoenix 7, Arizona.

It is reported that **Union Carbide Corporation** and **Kennecott Copper Corporation** have been staking large blocks of claims in the north section of the Hualapai Mountains south of Kingman, Arizona. Molybdenum, rare earths and rare metals are thought to be the attraction. **Duval Sulphur and Potash Corporation** recently suspended diamond drilling in the area but is continuing geological field work.

Kerr-McGee Oil Industries, Inc. have completed the location work on about 100 lode claims east of Alum Gulch on the slopes of Red Mountain, southwest of Patagonia, Arizona. Henry Vizcaino is the geologist in charge of exploration work.

California

United States Geologist Seeks Australian Iron Ore Deposits

Dr. K. G. Welker, chief geologist for Cyprus Mines Corporation, Los Angeles, California, and Professor K. C. Dunham, Geology Department, Durham University, England, have collaborated with R. S. Matheson, chief geologist, Consolidated Gold Fields (Australia) Pty. Ltd. in planning an airborne and surface geophysical program to find and delimit iron ore deposits in the Ellarine Hills.

Consolidated Goldfields-Cyprus Mines —Utah Construction and Mining were recently awarded prospecting rights from the West Australian government covering 308,256 acres east of the city of Port Hedlund. Many samples of plus-60-percent iron have already been taken by prospectors. The geologists are reported as "confident" that they can find a total of 50,000,000 tons of ore.

New Idria Mining and Chemical Company plans to build a new refinery in California for the production of metallic tungsten and other tungsten chemicals. The new facility will process the company's own high grade ore as well as custom concentrates from both domestic and foreign ores. **Stearns-Roger Manufacturing Company** of Denver has been awarded the contract to design, engineer, and construct the refinery, which will make New Idria a major producer of tungsten metal.

Underground work at the **Lone Pine** mine of **White Caps Gold Mining Company** has uncovered an 18-foot width of beryllium mineralization. The discovery was made by the drilling contractor, **Brownstone Mining Company**, and three samples assayed 7.77 percent, 7.12 percent, and 7.81 percent BeO. Hugh Cameron is mine superintendent for White Caps.

The **United States Borax & Chemical Corporation** and **Vitro Chemical Company** have signed a rare earths marketing agreement so that U. S. Borax will exclusively distribute Vitro rare earth products to the glass and ceramic industries in the United States, Canada, and Mexico. Vitro will continue to market its rare earth products in industries not normally served by U. S. Borax.

Central

Work has started on the new chemical plant of **Buckman Laboratories, Inc.** at Cadet, 50 miles southeast St. Louis, Missouri. The new plant will produce barium borates and other barium compounds from ore to be mined in the Potosi barite district. Although the company owns deposits of barite it expects to purchase all ore requirements from existing operating mines. Russell B. Buckman will be manager of the new plant which is expected to begin operations in March 1962.

Rosiclare Lead & Fluorspar Mining Company, Rosiclare, Illinois, has leased its flotation mill to Wiley Cochran, owner of the **Tamora Mining Company**, Elizabethtown. The Rosiclare mill is now in operation producing some 200 tons of acid grade fluorspar daily. Mr. Cochran also has under lease from the Rosiclare Lead and Fluorspar Mining Company certain fluorspar deposits in Hardin County, Illinois.

Among recent publications by the **U. S. Bureau of Mines** is Information Circular 7956 on mining methods and costs at **Crystal-Victory** and **Minerva No. 1** fluorspar mines of **Minerva Oil Company** in Hardin County, Illinois. The report describes methods of exploration, development and mining, giving costs for each. The report can be obtained for 50 cents from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Due to lack of orders for finished fluorspar, **Ozark-Mahoning Company's** fluorspar mill at Rosiclare, Illionis, and its heavy media plant near Cave-in-Rock, Illinois, were shut down for one week in September. The company's mines were not affected by the shutdown, and operated normal shifts.

A report issued by the **U. S. Bureau of Mines**, "Methods and Costs of Producing Brown Iron Ore at Two Small Southern Missouri Mines," is of particular interest to operators in the southeastern United States where brown iron ore is relatively plentiful. The costs and practices refer to a recent typical year when one of the mines produced 17,000 tons of washed ore and the other 21,000 tons. Copies of the report, Information Circular 7983, are available only from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 20 cents a copy.

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Colorado

Bol-Inca Buys South Platte Dredge For Move To Bolivia

The Bol-Inca Mining Corporation has contracted to buy the 11-cubic-foot connected bucket line dredge of the Natomas Company at Fairplay, Park County, Colorado. This is generally known as the South Platte dredge and is in excellent condition as it has been well maintained since it was forced to close in January 1952.

Bol-Inca plans to dismantle the dredge in 1962 and ship it to eastern Bolivia, South America to recover gold from the Sipiapo-Milliscuni placers along and in the stream bed of the Kaka River. The company reports 16,028,000 cubic yards of gravel there with an average gold content of $0.66 per cubic yard.

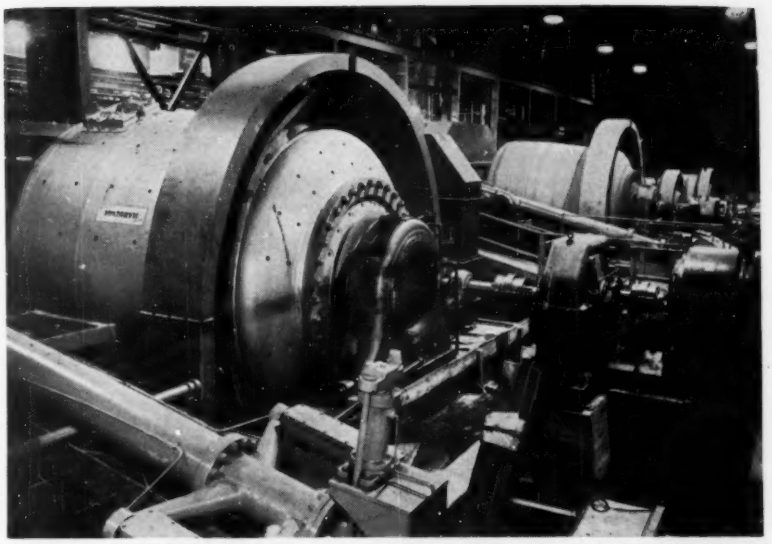
The South Platte dredge is an all steel unit with 103 buckets and is designed to dig 65 feet below the water line. It was commissioned in 1941 and dredged slightly more than 5,000,000 cubic yards per year until closed by the World War II gold limitation order L-208; dredging resumed in 1945.

Bol-Inca is now assembling its 4-cubic yard dredge shipped from Boise Basin, Idaho and should be dredging by early 1962 in and along the Rio Kaka at Uyape. Because of high water early in 1962 the dredge will be operated on the Uyape terrace. When the river goes down it will be moved into stream using head and bow lines and a spud. Ralph A. O'Neill is president with headquarters in Palo. Alto, California.

Climax Molybdenum Company now operates its **Phillipson** compressor station automatically to supply compressed air for mine operations. The five compressors are automatically started or stopped by an electronic control system which monitors demand and supply and actuates motor control switches. In the event of a compressor malfunction a warning light is turned on in the Phillipson machine shop one mile away. If the malfunction continues the machine is stopped. The new installation was installed under the direction of Urban Toucher and Jack Fugate.

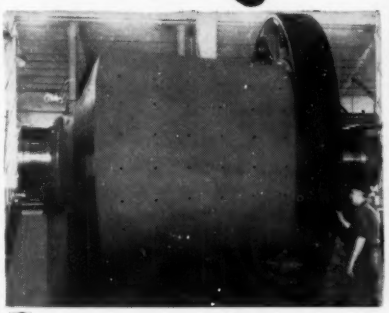
The largest hoist ever to be used at the Climax mine of **American Metal Climax, Inc.** was recently installed to serve No. 5 shaft, a service shaft between the Storke Level and the 600 Level, presently under development. The new hoist was purchased at a cost of $175,000, and is capable of hoisting 40,000 pounds at a designed speed of 800 feet per minute. In actual operations, though, the top speed of the hoist will be kept at about 500 feet a minute.

Denver-Golden Corporation is deepening **Schwartzwalder** uranium mine near Golden, Jefferson County an additional 300 feet. This will extend workings to a depth of 975 feet vertically below the original discovery level driven by Fred Schwartzwalder in 1949. The company mined and shipped 20,378 tons of 0.72 percent U_3O_8 ore with a total value of $233,882 during fiscal year ended 31 May. Shipments of this tonnage and grade will continue to the custom mill of **Cotter Corporation** at Canyon City, Colorado until at least February 28, 1965 under terms of sales contracts. Charles O. Parker, Denver assayer, is president.



11-3-6-10 Hardinge Tricone Mills in the Grinding Department of Opemiska Copper Mines, Ltd. Two Hardinge 8′ x 72″ Conical Mills can be seen in the Background.

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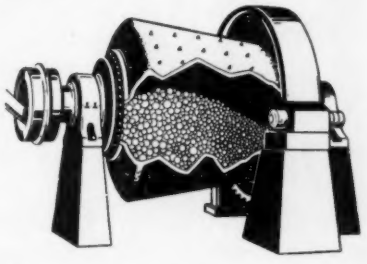


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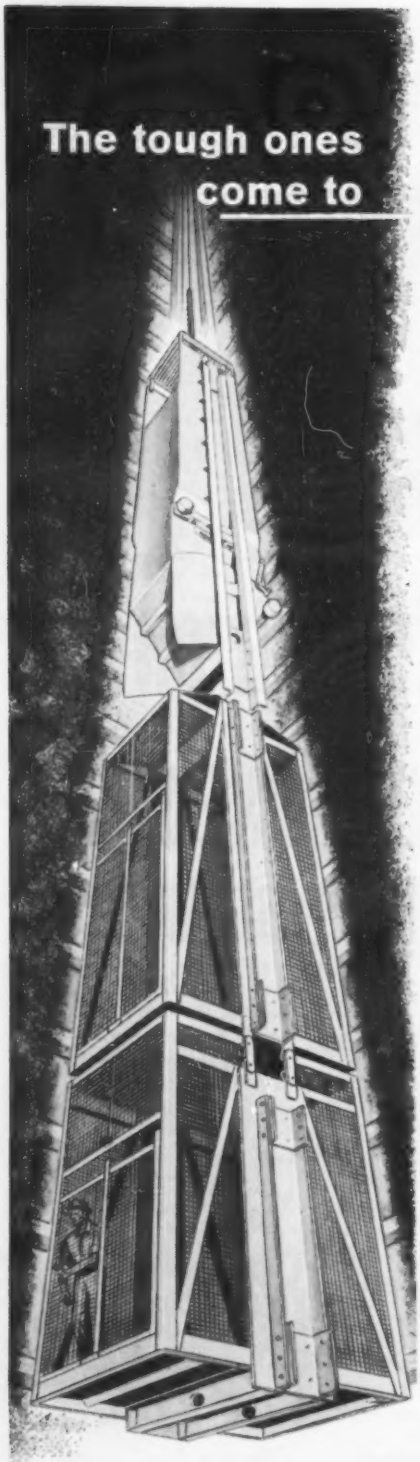
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Eastern

Mulberry Construction & Welding Company has begun erection of **International Minerals & Chemicals Corporation's** newest phosphate dragline, a Bucyrus-Erie 1250W, at the **Achan** mine near Mulberry. The big excavator, larger than any the company is now using, has been named the "Master Miner," and is expected to be placed in operation in January 1962.

Armour & Company has purchased 880 acres of Polk County phosphate land from the Jesuit High School Foundation, Inc., of Tampa for $1,500,000. The purchase consists of five tracts three miles west of Fort Meade, adjoining the new Armour phosphate processing plant now under construction.

Tennessee continues to grow as a mineral processing state. **Consolidated Aluminum Company, Ltd.**, a Swiss firm, has announced that a $27,000,000 basic aluminum plant will be built near New Johnsonville. Bauxite will be transported to the plant by barge from Gulf Coast processors. **Howe Sound Company** has also picked the New Johnsonville area as one of three possible sites for a $45,000,000 aluminum plant. Another group, headed by Ross Bohannon, an attorney from Dallas, Texas, is studying the Tennessee Valley area for a suitable site for a $42,000,000 steel mill.

Philip L. Lemoureaux, Alabama state geologist, has been making extensive coring tests in several southeast Alabama counties, and predicts that brown iron ore veins may extend across south Alabama from the Chattahoochee River into Mississippi and across the river into Georgia. Several hundred cores have been taken showing limonite thicknesses from two to 10 feet averaging about 50 percent iron. The tests are being made because of the interest of a Texas financial group in establishing a steel mill in the vicinity of Eufaula, Alabama.

Expansion of phosphoric acid production capacity to 400,000 tons per year was recently completed at **American Cyanamid Company's** Brewster operations. The two-fold expansion of acid capacity has been tied into the existing facilities and trial runs are now being completed.

Construction has begun on a new contact sulphuric acid plant at **Swift & Company's** phosphate center at Agricola which will supplement two existing acid plants, tripling present capacity. Output of the new acid plant will be used to treat phosphate mined at the site, with the resulting sulphuric acid used in production of the company's concentrated phosphate compounds.

A site in the Lexington Park section of Lexington, Massachusetts, has been purchased by **Kennecott Copper Corporation** as a location for its new Basic Research Laboratory. The coming research program will be aimed at obtaining fundamental knowledge and the discovery of new scientific facts pertaining to the metals industry. Dr. Ewan W. Fletcher, formerly of the Massachusetts Institute of Technology, is director of the new laboratory.

Armco Steel Corporation has proudly announced that one of its new blast furnaces at Middletown, Ohio, produced pig iron at the rate of 2,932 tons per day—or 87,960 tons for the month of June. This is believed to be a Free World record. The furnace was charged entirely with iron ore pellets produced by **Reserve Mining Company** with wind blown into the furnace at 1,500° F.

A special-made two-ton tram car for hauling development ore in the **Calloway** mine has been made in the mine shops of the **Tennessee Copper Company.** The advantage of this small car is that ore and waste can be unloaded the same as larger production cars at the present dumping station. Another recent development in the Calloway is the use of rock bolts and concrete to reinforce weak, fractured rock. A "scram" drift, 10 feet above the 20th level, was recently given a concrete lining in the interests of economy and safety. This was the first use of underground concrete reinforcement by the Tennessee Copper Company.

Idaho

The old **Peacock** mine of Cuprum, Idaho, last worked in 1916, is again operating with a production of 450 tons a month. An open pit operation, the claim is yielding 18 percent copper, which is being shipped to the Tacoma smelter of the **American Smelting and Refining Company.** Operators are H. M. Kleinschmidt, Otto Russel, and Jack Flower. The possibility of direct smelting on the site is currently being considered.

At the nation's largest silver mine, the **Sunshine,** of **Sunshine Mining Company,** in Shoshone County's Coeur d'Alene mining region, work has started on a new shaft which will be bottomed at a point more than 2,000 feet below sea level. The No. 10 shaft, which will reach well below present mining depths in the area, is being sunk from the present bottom 4,000-foot level of the mine and will continue to a depth of 4,750 feet. The shaft will permit development of new 4,200, 4,400, and 4,600 levels and will give access to a large new area nearly one mile east of the main Jewell shaft entrance to the mine on Big Creek east of Kellogg. The main target will be the **Chester** vein in the "Unit Area," which currently is yielding ore from the 4,000 level up to the 3,550-foot level. The Sunshine-Polaris vein systems also will be tested at the greater depths. Raising above the shaft has been completed to the 3,400-foot level. Preparing for the day when silver advances in price, Sunshine has installed a sand-fill system, is enlarging its compressed air and electrical distribution systems, and is overhauling its waste and material handling systems. The company currently is employing 425 men and producing 900 tons of ore daily. Robert M. Hardy Jr., Spokane, Washington, is president.

At the **Conjecture** silver mine in Bonner County, **Federal Resources Corporation** has completed deepening its new shaft from the 1,000-foot level to the 2,000. About 1,200 feet of crosscutting and drifting is believed necessary to reach the anticipated downward extension of the ore zone.

Gold dredging has been started in Idaho County's Florence Basin by **Idaho Mining & Milling, Inc.** The firm is using a 2½-cubic-foot connected bucket line floating Yuba dredge, augmented with jigs to recover fine gold which early-day placer miners were unable to catch in their sluice boxes. Philip W. Jungert, Lewiston, is president.

The ammonium phosphate plant that was moved from Anaconda, Montana, to Pocatello, Idaho, is now operating according to Grant Kilbourne, vice president and general manager for **J. R. Simplot Company,** the present owners. This plant was formerly owned by **The Anaconda Company,** and was dismantled and moved to Pocatello this past summer by **Austin Company** of Seattle, Washington.

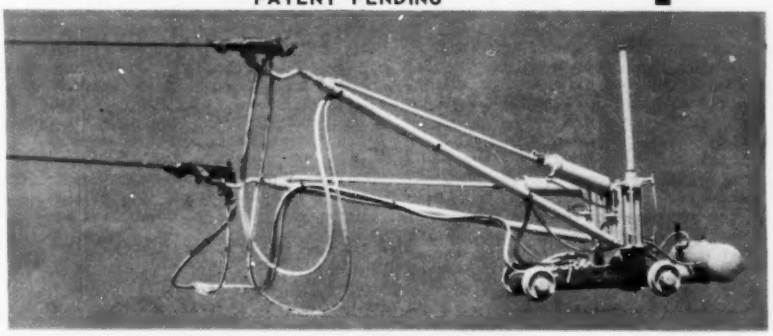
Exploration work on the 3,200-foot level of the Galena mine west of Wallace, Shoshone County, has disclosed the downward continuation of the new "North" silver vein first found in 1959 on the 3,000 level. A new "raise climber" machine is being used to complete driving of the No. 3 ventilation shaft, now virtually down to the 1,600 level. The shaft and related work will cost some $500,000. The mine is operated by **American Smelting & Refining Company** under lease from **Callahan Mining Corporation.** About 10,000 tons of ore assaying 38 ounces silver and 1.7 percent copper per ton is mined per month.

Princeton Mining Company is bulldozing its annual assessment work on claims in the Mullan area of the Coeur d'Alene Mining Region.

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Iron Ranges

Oliver Iron's New Sherman Concentrator Starts Operations

The Sherman concentrator, Minnesota's 80th and newest iron ore beneficiation plant, has begun operations. It is located at the Oliver Iron Mining Division's Sherman mine near Buhl, Minnesota, and is the third expansion in beneficiation facilities since the mine started operations in 1948.

Primarily, the Sherman concentrator will process low grade ores produced in Oliver's Monroe and Sherman mines, and will operate in conjunction with the previously built ore crushing and sizing facilities. It is designed to wash and scrub iron ores, process them through heavy media concentrating units, and treat them in cyclone and spiral concentrating equipment.

The mill includes four separate sections, each one an individual process to be operated separately or in conjunction with the others. The flow of crude ore through the plant begins in the washing section at the scrubber where fine ore and slimes are washed from larger chunks and the material is partially broken up for more efficient screening. Larger pieces go to a gyratory crusher where they are reduced to 1¼-inch size. Further treatment of both sizes consists of screening and washing. The coarse portion of the crude ore requiring further treatment then goes to the heavy media section, and the fine material direct to the cyclones and spirals.

Tailings from all processing units are pumped to the spiral sections where they flow through sets of spirals that extract fine particles of iron ore by centrifugal force. This concentrate is shipped with the fines from the cyclone section. The waste material is pumped into the tailing basin at Three Mile Lake, a small pond surrounded by mine dumps.

The **Zenith** underground mine at Ely, Minnesota, on the Vermillion Range was shut down temporarily for pumping operations. Heavy rains necessitated pumping to capacity and while the mine was closed emergency equipment was used. The unprecedented amount of water soon subsided and the mine was reopened. **North Range Mining Company** of Negaunee, Michigan, is operator of the mine, and **W. S. Moore Company** of Duluth, Minnesota, also ships from the mine.

First two participants in a new research program at **Michigan College of Mining and Technology** in Houghton are Dr. Hiroshi Kuno of Tokyo, Japan, and Dr. Adnan Goksel of Istanbul, Turkey. Both research specialists will spend a year at Houghton. Dr. Kuno, an assistant professor at Keio University, will continue study of froths in flotation environments, while Dr. Goksel, an associate professor at Istanbul University, is working on problems involved in pelletizing and briquetting Michigan's iron ores.

Lake Superior iron ore shipment, from upper lake ports totaled 13,510,651 gross tons up to July 1, 1961, compared to 28,839,841 for the same six month period in 1960.

The **Cleveland-Cliffs Iron Company** has received three Euclid mine trucks for haulage duty at the **Republic** open pit mine at Republic, Michigan. These trucks, which are 60 tons capacity each and powered by twin motors, are the largest trucks yet in the low grade iron mining scene on the Marquette range. Each twin motor power plant is rated at 660 horsepower. The new trucks are part of the new equipment required for the mine and plant expansion program presently underway at the Republic mine.

Empire Mining Company is building a pilot plant at Palmer, Michigan, on the Marquette Range to determine the commercial scale flowsheet for its Empire mine. Empire ore is unique for this range as it is the only known large deposit of magnetite. However, very fine grinding is necessary for mineral liberation. The **Abe W. Mathews Engineering Company** of Hibbing, Minnesota, has the design and an engineering contract for the pilot plant from the Empire operator—**Cleveland-Cliffs Iron Company.**

The 4,000,000th ton of iron concentrate was shipped by **Pioneer Mining Company** in August from its **Mary Ellen** heavy media separation mill west of Biwabik. Approximately 12,000,000 tons of ore has been mined from the Mary Ellen open pit to produce this concentrate. Frank Bergstrom, Pioneer president reported the mile-stone shipment to MINING WORLD on a recent visit to the Mesabi Range.

The **Abe W. Mathews Engineering Company of Hibbing,** Minnesota is designing and building the new pellet loading facilities at the Republic, Michigan, mill of **Cleveland-Cliffs Iron Company.** The existing flotation concentrator is being expanded and a new pelletizing plant built at Republic to raise capacity to 1,600,000 annual tons of high grade concentrate.

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Montana

Custom Mill Construction Planned at Radersburg

J. C. Forkner, owner of gold, copper and lead deposits in the Park district near Townsend and Radersburg, Montana, has begun construction of a mill near Radersburg.

The mill will be gold amalgamation followed by flotation, which can be easily changed to a selective lead-copper-zinc circuit. Custom work will be done on lead, zinc, gold, silver and copper ore from deposits located in the Winston, Townsend, Park and Radersburg areas. Much of this ore cannot now be shipped directly to a smelter because of low grade or high arsenic content.

W. R. Wade, consulting engineer of Marysville, Montana, will design and supervise construction of the mill.

The **Anaconda Company** announced a $1,250,000 major mine ventilation project. The project will extend the **Never Sweat** shaft from the 2,800 level on an incline to the 4,500 foot level of the **Steward.** This new shaft will provide a new exhaust outlet of 300,000 cubic feet of air per minute, and will greatly aid in ventilating a good ore block in the Steward.

Spokane National Mines, Inc. has acquired the **Quien Sabe** silver mine and **Hendricks** gold mine, and has rehabilitated the Hendricks flotation and cyanidation mill at Bannack, Montana. Current operations centered around the Quien Sabe mine, where a 10-man crew is producing two tons of high-grade silver ore per day that is trucked seven miles to the Hendricks mill at Bannack for processing. The mill has a capacity of 150 tons a day, and additional ore is expected to come from the nearby Hendricks gold mine.

There were two mining companies incorporated in Montana during the past month. The **Northern Continental Inc.** of Helena was chartered to engage in mining and milling operations. The **P. & P. Mining Company** of Helena was chartered with a capital value of $50,000.00.

The Multi-Mineral Products Company of Billings has completed negotiations for an agricultural gypsum deposit south of Bridger. The gypsum from this deposit has been used, unprocessed, by farmers in this area to condition their soil. The gypsum is to be processed and packaged at the company's Red Lodge plant.

The **Anaconda Company** still needs contract miners in the Butte operations. Mr. Hannifan, manager of mines, said that over 400 miners had been added to the payroll in August and that another 50 men could be used. In late August the need for production workers became so critical that the work on reopening the **Leonard** mine was stopped and the miners were transferred to the **Kelly, Mt. Con,** and **Steward** mines. This suspension is only temporary and plans call for continuing work on the Leonard as soon as the man-power becomes available. There were 100 men employed at the Leonard.

Raven Mining Company of Kalispell and **Basic Metals Mining and Milling Company** of Helena have recently been incorporated in Montana.

The **Montana Bureau of Mines and Geology** in Butte has a new publication ready for distribution at $1.75 per copy. It is Bulletin 22, entitled "Montana Mining Law" written by Koehler Stout. This bulletin discusses general mining law and the law relating to leasing act minerals.

Nevada

Utah Construction and Mining Company has recently completed development work on its **Dayton** iron ore deposit near Carson City, Nevada. A substantial body of iron ore has been blocked out that will require beneficiation to upgrade the iron content and remove excess sulphur. The company plans to bring the property into production as soon as possible, with the iron ore going to either steel mills in the west or to Japan.

The **U. S. Bureau of Mines** is preparing a report of the Mt. Washington beryllium deposit now being developed by **The Anaconda Company** south of Ely. The report will probably state that the Bureau has "successfully" concentrated the ores from the area, but that economics as to the production of BeO or beryllium metal will depend on the size of the concentrator, ore reserves in the district, and other factors.

New Mexico

Subject to the approval of stockholders, **Sabre-Pinon Corporation** and **United Nuclear Corporation** plan to merge. The plan calls for United Nuclear, a nuclear fuel and reactor core producer, to exchange one share of its common stock for each two shares of Sabre-Pinon, a New Mexico uranium mining and milling concern.

Marion Bolton, general manager of **Kermac Nuclear Fuels Corporation,** was a recent speaker at the Grants Lions Club, and stated that there are less economical reserves in the Grants area than first estimated. He went on to say that at the present time, with the high cost of mining, some of the ore isn't feasible, but this would probably be solved through new methods of mining which the industry is currently studying.

The Atomic Energy Commission has exercised its option to extend the term of the contract with **Kerr-McGee Oil Industries, Inc.** covering production from the Shiprock, New Mexico, processing mill, from June 30, 1965 to December 31, 1966, with no increase in the over-all commitment for the purchase of U_3O_8 in concentrate.

New Jersey Zinc Company has leased **Kennecott Copper Corporation's Oswaldo** zinc mine near Santa Rita. The mine was closed down at Kennecott in 1952.

Quinta Corporation is now operating the **Churchrock** uranium mine north of Gallup, New Mexico and shipping ore to **Phillips Petroleum Company's** Ambrosia Lake uranium mill for processing. Phillips previously sunk a shaft, developed the mine under difficult water conditions, and shipped ore to its own mill. Quinta brought suit against Phillips which was settled agreeably by letting Quinta operate the mine.

International Minerals and Chemical Corporation is building a new 10,000-ton crude storage building at the collar of its No. 1 potash shaft east of Carlsbad. When the building is completed in October it will assure surge capacity for the mine and mill. With this storage either the mine or mill can operate almost 24 hours independently of each other. This will assure continuous production of potash from the mill. **Fisher Contracting Company** of Phoenix, Arizona designed and is building the storage and ore reclaimation unit. E. C. Skinner is potash manager for International.

Alaska International Corporation is now operating the **Joseph** mica mine in the Ojo Caliente mining district in northern New Mexico's Rio Arriba County. A $100,000 mobile processing and treatment plant that produces a clean mica product without the use of water was recently installed at the 100-acre mine site. James V. Reynolds is president of Alaska International, and Martin Pollock of Santa Fe is superintendent of operations at the mine.



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When the Inter-American Industries Conference was scheduled for Chicago, Illinois, Thomas M. Ware, president of International Minerals & Chemical Corporation, undertook arrangement of a mining seminar as part of the conference. He felt that such a seminar was appropriate because mining, of one kind or another, is common to and important for all the Americas. When the seminar was held Canadian and Mexican delegates expressed their views on mining to engineers from six countries. Pictured above are speakers being welcomed by seminar chairman, Nelson C. White, vice president of International Minerals (center). Principal speakers seated from the left are: Jose Campillo, president of the Mining Federation of Mexico; V. C. Wansbrough, managing director of the Canadian Metal Mining Association; M. C. Ankeny, director U. S. Bureau of Mines; and D. K. Brena, representing Mexico's Minister of National Patrimony.

Utah

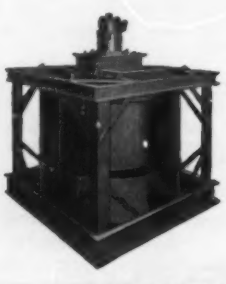
Crypto Iron Ore Anomaly To Be Drilled By Utah Construction

Under terms of an exploration and development agreement Utah Construction and Mining Company will start a diamond drilling program in the near future on claims of Pinnacle Exploration, Inc.

Crypto is the name given to an important geophysical anomaly near Fish Springs in eastern Utah which has been studied by Pinnacle for three years under the direction of Professor Mead LeRoy Jensen of Yale University's department of economic geology. Utah's chief geologist, Hollis Peacock, will direct Utah's operations.

Pinnacle is an 80 percent owned subsidiary of Callahan Mining Company with large silver holdings in Idaho's Coeur d'Alene district. Utah Construction owns and operates iron mines as well as contract-mines iron ore in the Cedar City district about 70 miles south of Pinnacle's claims.

More than 300 beryllium claims held by **Topaz Beryllium Venture, Inc.** in the Spors-Topaz mountain district, 55 miles northwest of Delta, have attracted the attention of **The Anaconda Company.** Drilling rigs have been moved in to evaluate the reserves of beryllium ore on the west side of Spors Mountain that reportedly average better than one percent BeO. Topaz Beryllium Venture located the Spors Mountain claims in 1960, and completed an extensive drilling program in 1961 which indicated a substantial ore tonnage amenable to open pit mining.



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The **Anaconda Company** has secured modification of certain options on mining claims in the Milford area and plans to continue surface drilling for disseminated copper deposits. Holes have been drilled on claims near the **Cactus** mine and between the **O. K.** and **Old Hickory** mines. Ground has been optioned from the **Cerro Verde Mining Company** and certain individual owners.

Construction of the 30.69-mile-long branch line of the Denver and Rio Grande Railroad Company from Crescent Junction to the new station of Potash has begun by **Morrison-Knudsen Company.** The new line will reach the **Cane Creek** potash mine and mill being developed by **Texas Gulf Sulphur Company.**

High grade silver lead ore has been found in the No. 1 winze below the **Wasatch drain tunnel** in the Alta district by **Grand Deposit Mining Company.** The winze is being sunk to follow the Cardiff fissure carrying gold-silver-lead-copper-zinc ore. Charles A. Steen, Reno, Nevada is company president; mine operators are Mr. and Mrs. J. J. Beeson, Salt Lake City, geologists.

Freeport Sulphur Company has reportedly offered $26,000,000 for **Uranium Reduction Company's** mill and mine properties, and **Utex Exploration Company's Mi Vida** uranium mine. The 1,500 ton-per day mill at Moab, Utah, processes ore from the Big Indian district where the Utex mine is located. Owners of Uranium Company include **American Zinc, Lead & Smelting Company, Hidden Splendor Mining Company** (subsidiary of **Atlas Corporation**), Utex Exploration, and the **Millbank** interests of New York City.

Production during the first six months of 1961 at the **Radon** property near Moab, Utah, amounted to 25,440 tons of ore mined and sold assaying 0.70 percent U_3O_8, of which 25 percent, or 6,360 tons, were for the account of **Hecla Mining Company.** An additional 3.128 tons of ore assaying 0.40 percent U_3O_8 were produced from the **Hot Rock** property of which 50 percent, or 1,564 tons, were for the account of Hecla. Although mining in the Hot Rock has continued at a limited rate, very little additional production is expected.

The **Butterfield** lead-zinc mine will be reopened with a 1,450-foot tunnel by the **United States Smelting, Refining & Mining Company** in the Lark-Bingham district south of Salt Lake City. The company has started work on driving a tunnel under the **U. S.** and **Lark** mines to a point under the present workings at the Butterfield mine, and will then raise to a lead-zinc ore body in the **Butterfield Canyon** property. The multi-million dollar job will take some 28 months.

United Park City Mines Company, silver-lead-zinc producer in the Park City district, has reported $12,907 net income before depletion for the first six months of 1961. This net was produced from a total income of $872,050. According to the company the small profit was attained as a result of new efficiencies and economies, and a slight increase in ore grade. For the first six months of 1960, United Park City had a net loss of $78,-756 before depletion on a total income of $1,020,733.

General Beryllium Corporation is diamond drilling its claims in the Topaz Mountain area of Utah seeking to determine beryllium ore reserves. Stuart R. Kaplan, vice president, reports that General Beryllium has the **Dick Moody** group of claims under option. Location of these claims is shown on page 21 on the September 1961 issue of MINING WORLD.

Details of "longwall retreat" mining, as used in the **Radon** uranium mine of San Juan County, Utah, are discussed in a publication released by the **U. S. Bureau of Mines.** The Radon mine is one of the first metal mines known to use the method with steel yielding props, which are withdrawn as the ore is removed on "retreat," after operations have reached the farthest limits. Information Circular 8004, describing this mining technique, can be obtained free from the Publications-Distribution Section, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh 13, Pennsylvania.

Washington

Daybreak Uranium, Inc., has resumed work at its **Dahl Lease** in the Mount Spokane dictrict, Spokane County. At last report, 260 tons of stockpiled autunite was being trucked to **Dawn Mining Company's** Ford, Washington, uranium processing plant. The ore was mined by Herbert Sams, Elk mining contractor, with bulldozer and loader, from ore pods found 15 to 22 feet below the surface by downhole drilling. Kae Sowers, Opportunity, Washington, is secretary of Daybreak.

An open-pit mining operation now is being carried on at the old **Peacock** mine in Adams County by **Western States Mines, Inc.,** of Cuprum, Idaho, and San Francisco. Five men are employed and direct-shipping grade copper ore is going to the Tacoma smelter. The mine had been idle since 1916. H. M. Kleinschmidt is company president.

A district tunneling record was believed made at the Schumaker lead-zinc mine north of Colville, Stevens County, when crews drove 420 feet in July. **Goldfield Consolidated Mines Company,** which recently acquired a 51 per cent interest in the mine from **Triton Mining Company** of Colville, is driving a 1,000-foot lower adit to gain 350 feet of depth on an ore body discovered last year by Triton in extending an old hand-driven tunnel. The adit will be connected by raise to the upper tunnel where an ore body was opened for a distance of 600 feet. Truman (Cy) F. Higginbotham is area general superintendent for Goldfield.

Triton Mining Company is extending a drift at its **Pioneer** mine, northeast of Colville, Stevens County, to investigate one or two interceptions of silver-bearing ore made with recent diamond drilling. Darrell A. Newland, Colville, is president.

A dolomite deposit at the old **Crystal City** lead-silver mine near Miles, Lincoln County, Washington, is to be investigated by a newly organized Seattle firm, **Dolomite Products Company.** Its organizers are Vernon and Larry Helm, who also plan to diamond drill the lead-silver vein. Luke C. Williams, of Spokane, is president of **Crystal City Mining Company** which has leased to the Seattle firm.



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The **Bunker Hill Company** has taken options to purchase the **Bonanza, Old Dominion,** and **Clugston** mining properties in northern Stevens County, The Bonanza and Old Dominion mines yielded some of the highest grade lead and silver ore ever produced in the northwest. At one time **The Anaconda Company** had the Bonanza under option for a $2,000,000 purchase price, but relinquished the option in 1958 after extracting an undisclosed amount of ore. The Clugston Creek property includes the **Big Chief** group of mining claims, and the adjoining **Chloride Queen** property.

At the **New Departure** silver mine southwest of Dillon, Beaverhead County, **Spokane National Mines, Inc.,** is drifting on an ore shoot from the bottom of a new 60-foot shaft. Fifteen tons of high-grade and some mill-grade material were mined in the sinking process. At last report the company was installing a fine crusher at its **Bannack** mill to custom-mill 10,000 tons of silver ore from the **Polaris** mine. George Allison, Spokane, Washington, is company president.



Unique Tandom Scrapers Speed Stripping In Wyoming

In the Gas Hills area of Wyoming, Sharrock & Pursel Mining Company of Casper, Wyoming, stripped 7,500,000 cubic yards of sandy clay and hardpan from uranium deposits last year. The company uses LeTourneau-Westinghouse B Tournapulls which were recently tandemized by adding a second scraper to each machine, as shown above. This use is a radical departure from conventional scraper operations.

Wyoming

The concrete-lined production shaft at the new soda ash mine of **Stauffer Chemical Company** was completed in October when the 900 foot shaft reached the lower bed of trona ore. Other jobs at the project site, 21 miles northwest of Green River, are progressing on schedule with workmen's efforts directed toward closing in all buildings before the onset of severe winter weather.

Highest grade uranium ore in Wyoming was mined during 1960 by the **Utah Construction and Mining Company** from **Shirley Basin.** The 22,286 tons had an assessed value of $566,386. This was the fourth largest mine in point of tonnage mined underground.

Phelps Dodge Corporation's subsidiary —**Green Mountain Uranium Corporation**—mined 29,495 tons of ore from its **Green Mountain** underground uranium mine in the Crooks Gap district in 1960.

A plan for the development of an extensive gypsum deposit on the Wind River Indian Reservation was outlined by Alfred Ellerby, president of the **Vipont Mining Company,** to Rep. Wilbur Mills, chairman of the Ways and Means Committee of the House of Representatives, Washington, D. C. The plans include, in addition to mining the gypsum, construction of a drying plant on the reservation and building a new railroad from Shoshone to the deposit. Indians of the reservation will have priority for employment on all phases of the operation.

Allied Chemical Company has applied to the State of Wyoming for water rights adjacent to its reserve of trona, 12 miles west of the Green River on the west side of the Black Fork River. This indicates the company will undoubtedly go ahead with multi-million dollar plans to develop the trona mine and construct a beneficiation plant, since any water right secured in Wyoming must be placed in beneficial use if the rights are to be maintained. The company has also held discussions with the Pacific Power & Light Company relative to energy requirements for the mine and plant.

The joint venture of **Stauffer Chemical Company** and the **Union Pacific Railroad Company** in Wyoming aims at a mid-1962 completion date for the $15,000,000 natural soda ash mine and mill near Green River. Trona beds between 800 and 900 feet below the surface will be mined, and processed in a 200,000-ton-per-day processing plant. A man-way shaft has been completed to 900 feet, and a 22-foot circular haulage and ventilation shaft is below the 650-foot mark.

Western Nuclear, Inc., operating in the Gas Hills, Wyoming, had a net income of $1,296,207 for the 12 months ending June 30, 1961, or equal to 56.5 cents a share. The company had a net of $1,226,716 or 53.5 cents a share in the previous fiscal year. Robert W. Adams, president, stated in a letter to stockholders that a $6,000,000 bank loan had been reduced to $2,525,000 as a result of pre-payments, and the company planned on prepaying another $150,000 by next December.

The largest underground uranium mine in Wyoming in 1960 was the **Hauber** in the Black Hills operated by **Homestake Mining Company** which produced 72,143 tons of ore.



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Parsons on Copper

continued from page 29

costs attained by companies operating under comparable conditions. On this basis I have made what I think are close approximations to the costs of all important mines.

Appropos of costs I venture one more observation. In my opinion the purported advantages of so-called "cheap labor" have been largely mythical. Low wage-scales do not necessarily produce low labor costs or low production costs. If Sir Ronald Prain of Rhodesian Selection Trust, or Robert Koenig of Cerro de Pasco, or Robert Page of Phelps Dodge had in his pocket a fabulous ore deposit and could plant it wherever he wished I think any of them would select the Arizona desert in preference to either Africa or South America.

If the foregoing estimates are approximately accurate I think the copper producers, by and large, will be content with a price not exceeding 32 cents for the next few years. I think they will strive to prevent a run-away market by expanding output as needed. Incidentally, I think they also will exercise the remedy of curtailment to prevent the price from sagging to 26 cents even for a short time.

In Chart No. 2 I have shown this 26 to 32 cent price range (remember, in 1960 dollars) as prevailing for about 12 years. The basis of this forecast is the fact that equipped capacity already in existence or definitely projected is more than sufficient to supply expectable demand until after 1976 (see Chart No. 1). The plants and facilities had been projected on the basis of economic conditions existing in 1960 or earlier.

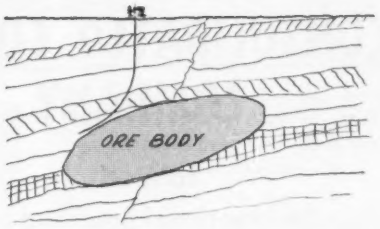
However, there has been a gradual decline in the average grade of copper ore as mined. According to the U.S. Bureau of Mines this average in the United States has been in recent years less than 0.8 percent compared with an average of 1.6 percent in the decade of the 1930's and 1.0 percent in the decade of the 1940's. Notwithstanding the high grade of many deposits in foreign countries, especially in Africa, taking the world as a whole as time goes on it will be necessary to draw upon leaner and leaner reserves. In the United States the average could fall to 0.5 or 0.6 percent; and it seems more than likely that, in large scale operations, ore averaging no more than 0.4 percent, equivalent to a content of 8.0 pounds per ton, will be exploited.

As I already have pointed out, the room for lowering production costs, through technologic and engineering advances, though important, is restricted—particularly in the direction of improvement of percentage recoveries in ore treatment. The cost of exploration and prospecting; and the capital cost of facilities for mining and treating leaner ore on a per-pound-of-copper basis will be higher. Consequently there will be a pregressive increase in the true cost of producing a pound of copper; and that inevitably will mean an increase in the world market price.

How rapid will be the rate of increase and how high will the price go by A.D. 2000? Only a soothsayer knows the answer; but on Chart No. 2 I have ventured to plot a band with a range, starting at 6 cents in 1962 and ending with 8 cents in A.D. 2000, that I think will provide a statistical resting place for the annual averages as they become historical. At the far end, as can be seen, the range is from 40 to 48 cents. END

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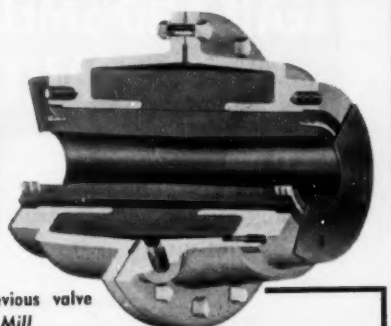
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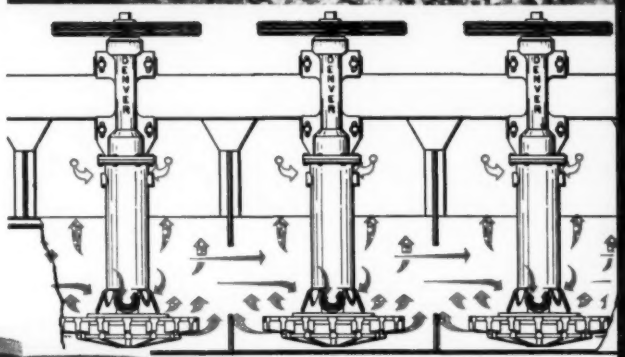
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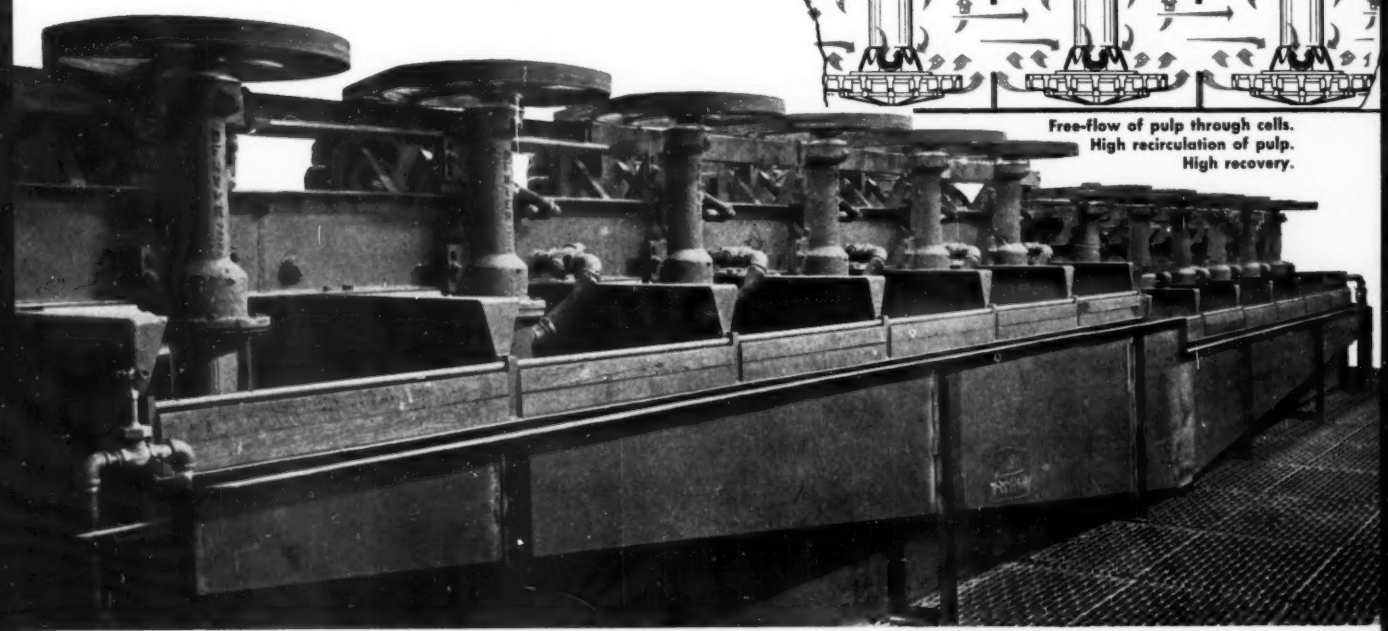
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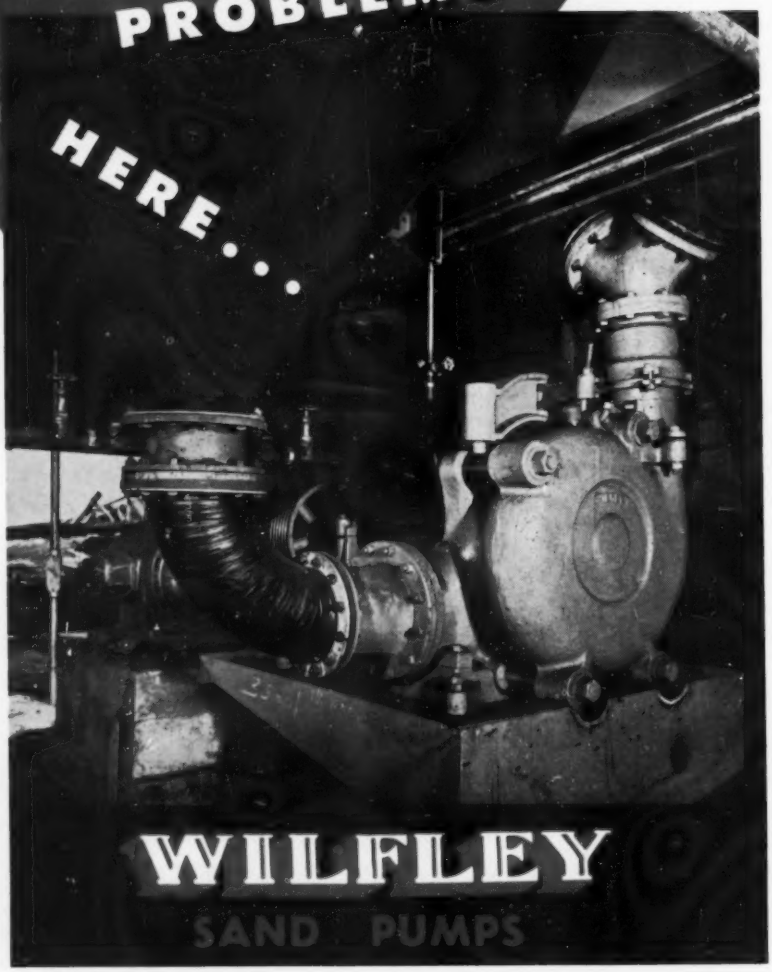

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